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PRELIMINARY DESIGN REPORT FOR THE YAKIMA/KLICKITAT PRODUCTION PROJECT

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ACKNOWLEDGMENTS

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LIST OF ACRONYMS

BPA	Bonneville Power Administration
COUNCIL	Northwest Power Planning Council
CRFMP	Columbia River Fisheries Management Plan
cwu	Central Washington University
EA	Environmental Assessment
EDWG	Experimental Design Working Group
EPA	Environmental Protection Agency
EWU	Eastern Washington University
FMC	Fish Management Consultants
GSI	Genetics Stock Identification
HE-TWG	Hatchery Effectiveness Technical Working Group
IHN	Infectious Hemopoetic Necrosis
MEG	Monitoring and Evaluation Group
MSY	Maximum Sustained Yield
NMFS	National Marine Fisheries Service
OSY	Optimum Sustained Yield
PNL	Pacific Northwest Laboratory
PSU	Portland State University
PNUCC	Pacific NW Utilities Conference Committee
PNFHPC	Pacific Northwest Fish Health Protection Committee
PFMC	Pacific Fisheries Management Council
STWG	Supplementation Technical Working Group
STORET	EPA data storage system
TWG	Technical Working Group
USBR	US Bureau of Reclamation
USFWS	US Fish and Wildlife Service
WDF	Washington Department of Fisheries
WADOE	Washington Department of Ecology
WDW	Washington Department of Wildlife
wsu	Washington State University
YIN	Yakima Indian Nation
YKKP	Yakima/Klickitat Production Project

EXECUTIVE SUMMARY

A master plan for the Yakima/Klickitat Production Project (YKPP) was developed by the Northwest Power Planning Council (Council) on October 15, 1987, as a reasonable basis upon which the Bonneville Power Administration (BPA) could proceed to fund predesign work on the project. The Council approved the predesign work on the condition that eight preliminary tasks were completed. These tasks are:

Task 1. Agreement on a refined statement of project goals.

Task 2. Completion of a technical analysis of water supplies.

Task 3. Completion of an experimental design plan.

Task 4. Development of a harvest management plan.

Task 5. Assessment of potential genetic risks.

Task 6. Project coordination with all other affected parties.

Task 7. Submission of a preliminary design report to the Council.

Task 8. Develop a project management structure.

The preliminary design report summarizes the work completed on these tasks. It provides a description of the preliminary design, engineering, and construction phases of project development, and gives an estimate of project costs. Also included is a description of other studies that were conducted to support YKPP planning.

The results of studies conducted during the last 30 months indicate that hatchery facilities can be built in the Yakima and Klickitat subbasins to provide harvest benefits and to supplement natural production. Planning for the Yakima subbasin is at a more advanced stage of development than for the Klickitat subbasin because of greater availability of basic resource information. The information needed to proceed with final design and construction for the Klickitat subbasin will be available by 1992, as ongoing predesign work continues. This schedule is consistent with the anticipated phased completion of the YKPP by 1997.

Three general types of facilities are planned for the YKPP. One or more central hatchery facilities will be built in each subbasin for adult holding, egg incubation, and juvenile rearing. Clusters of standardized ponds will be constructed by streams targeted for supplementation, where juvenile fish will be acclimated.before being released. Some adult and juvenile trapping facilities already exist and are operating in the Yakima subbasin, additional facilities are needed in both subbasins. These facilities will be used for broodstock collection and for sampling upstream and downstream migrants.

COORDINATION AND CONSULTATION

Extensive coordination is required for the YKPP because of the complexity of the technical issues, the number of public and private interest groups involved, and because of the wide geographical area over which fish will be produced and ultimately harvested. BPA has developed a number of coordination and consultation activities for the project. For example, BPA has developed a Public Involvement Plan, with inputs from technical working groups (TWGs), to involve interest groups and individuals in the Yakima and Klickitat subbasins with project planning. The TWGs are comprised of representatives of various Council work groups, including those involved in fish health protection, the Monitoring and Evaluation Group (MEG), supplementation, and subbasin planning. These representatives coordinate TWG issues with the various Council groups. Additionally, a task team for coordination activities consults with other interested parties.

The Yakima Indian Nation (YIN) has appointed a project manager to interface with the BPA project manager and the project leader. The project TWG meets monthly to review the technical progress and to recommend action or submit questions to the project managers and various task teams. Task teams are subcommittees of the Hatchery Effectiveness TWG (HE-TWG), and are responsible for progress in coordination, water analysis, tributary issues, experimental design, disease strategies, engineering, environmental issues, and the sockeye reintroduction feasibility study. Task team efforts are coordinated with the system-wide TWGs, specifically the MEG, the Supplementation TWG, the HE-TWG, and the Fish Health Protection Committee (FHPC).

The Experimental Design Work Group (EDWG) provides coordination for the biological aspects of the YKPP. Its coordination role includes assuring consistency between project goals and scientific activities and communicating biological requirements to the management entities and technical groups. The EDWG is also responsible for coordinating YKPP research activities with other fishery programs within the Yakima and Klickitat subbasins, and system-wide within the Columbia Basin. Note, however, that the fundamental role of EDWG is not coordination and consultation, but the establishment of standards for experimental design and data analysis.

Public information and involvement began with the development of the Council's Yakima and Klickitat Rivers Central Outplanting Facility Master Plan. This report involved BPA, the Council, the YIN, state and federal management agencies, Yakima Irrigation Districts, and others. Various interest groups were contacted informally during implementation of the predesign study to discuss the project and related issues. The formal coordination process with the general public has included meetings with landowners, sports groups, irrigation districts, and other special interest groups. Coordination activities with sport fishing groups dealt primarily with concerns regarding potential impacts to rainbow trout above Roza Dam and on distinctions between wild and hatchery stocks of steelhead in the Klickitat system. Coordination activities were also initiated with individuals owning land contiguous with tributary streams. A Tributary Task Team was established to meet with landowners in an effort to resolve problems currently limiting salmon and steelhead production in tributaries.

Yakima/Klickitat Production Project newsletters have been distributed by BPA and management agencies. Feature articles in the Yakima Basin Resource News and the BPA Backgrounder were distributed to the public to provide background information on the project and current status of planning efforts. BPA has also produced several videos and coordinated press releases on the project for public information.

PROJECT MANAGEMENT STRUCTURE

The BPA is serving as the overall project manager for the YKPP and has responsibility for schedules, contracts, and submitting the Preliminary Design

Report to the Council. The project is managed from the BPA Yakima Project Office in Yakima, Washington. A project leader acts on behalf of the management entities to coordinate efforts of the fishery managers, and to identify the policy issues which require resolution by the appropriate decisionmakers.

A YKPP TWG was formed in late 1987 and is composed of experts in hatchery production, natural production, harvest management, and fish health. Technical work group members also serve on other system work groups such as the System Operating Advisory Committee, the MEG, the Fish Health Protection Committee, the HE-TWG, the Supplementation TWG, and the Subbasin Planning Group. The YKPP TWG is further split into task teams that provide technical guidance in specific areas.

The fisheries managers have created a policy-level review group comprised of representatives of the YIN, the Washington Department of Fisheries (WDF) and the Washington Department of Wildlife (WDW). This group resolves policy issues which relate to production, harvest, and genetics, as well as policy issues identified by the TWG. Policy-level attention will be required for the life of the project.

REFINED PROJECT GOALS

A refined statement of project goals was jointly developed by the YIN, the WDF, and the WDW. In establishing these goals and objectives, the managers also endorsed the adaptive management policy adopted by the Council for the YKPP. This approach recognizes that achievement of stated objectives is subject to uncertainty, and that strategies must be evaluated and revised in the light of new information.

The purpose of the YKPP is to supplement and enhance natural production of salmon and steelhead stocks in the Yakima and Klickitat subbasins, not to replace natural production. Accordingly, spawning and rearing habitat should continue to be protected and enhanced. The Yakima and Klickitat Subbasin Plans focus on habitat enhancement in a general sense. Planned YKPP programs are fully compatible with these subbasin plans, but do not assume or require that they de implemented. However, any measure, including those in the

subbasin plans, that enhances natural production will increase the effectiveness of the YKPP.

The YKPP proposes to enhance existing stocks while preserving their basic character, adaptability, and fitness. The best adapted stocks will be introduced in cases where the species is no longer present. The success of the project requires the critical uncertainties be systematically investigated by controlled scientific experiments. Four categories of population responses have been identified, in terms of which alternative supplementation strategies will be evaluated. They are:

1. The post-release survival of hatchery-reared fish.
2. The homing and reproductive success of supplemented populations.
3. The long-term fitness of supplemented populations.
4. The inter- and intra-specific interactions (including competition, predation and genetic effects) between supplemented and unsupplemented populations.

Supplementation strategies (treatments) hypothesized to affect these responses will be administered in the context of controlled experiments. Factors not varied experimentally will be kept constant by means of quality control programs and/or monitored. Hatchery practices are not considered a critical uncertainty, and will therefore be managed as experimental constants,

The YKPP includes eight different stocks: spring, summer, and fall chinook salmon, coho salmon, sockeye salmon, and steelhead trout in the Yakima subbasin; and spring chinook salmon and steelhead trout in the Klickitat subbasin. The relative emphasis supplementation objectives place on natural versus hatchery production varies by stock, ranging from primarily natural, in the case of Yakima spring chinook, to primarily hatchery, in the case of Yakima coho. Supplementation opportunities may indeed vary <u>within</u> a stock, depending on the outcome of ongoing substock identification work.

The YKPP proposes to increase both the production potential and the stock status of targeted stocks. Production and harvest potential will be enhanced by increasing the number of smolts (and thus adults) produced per spawner. This increase in productivity will be a consequence of the egg-to-smolt survival advantage of hatchery rearing experienced by a portion of each

run. The central hypothesis of the YKPP is that a significant part of this advantage can be sustained through the natural lifecycle (survival-to-adult, natural spawning and production of fit offspring).

A goal closely associated with the goal of increased productivity is the goal of improving the "status" of supplemented stocks. "Stock status" refers to abundance in relationship to carrying capacity or, roughly, to the level of "seeding." The goal of the YKPP is to increase and maintain stocks at levels permitting or approaching "maximum sustained yield" (MSY). Maximum sustained yield stock status is achieved when sustainable surplus production--production in excess of that needed for population replacement--is maximized. It should be noted that management of the Yakima and Klickitat subbasins will require somewhat lower exploitation rates and sustainable surplus production than MSY if it becomes necessary to protect a weak substock (e.g., if unsupplemented substocks cannot sustain MSY harvest).

Adult production objectives for the YKPP are derived from and are expressed in terms consistent with the Council's System Planning Model. The approach is based on the expected long term production of adult equivalents under a maximum sustained harvest policy. The adult equivalency computations include prior harvest and are expressed as adults entering the subbasin.

A major element of this project is the conservation of genetic population characteristics currently found in the wild and natural salmonid populations of the Yakima and Klickitat subbasins. Six of the more important strategles intended to minimize adverse genetic impacts on natural populations are as follows:

1. Identification and separate culture of distinct substocks which are to be outplanted in the ancestral drainages only.
2. Marking all hatchery juveniles and using only unmarked adults as broodstock.
3. Collection of no more than 20% of the return of a given stock for broodstock.
4. Implementation of mating schemes that maximize genetic diversity of offspring.
5. Reduction or elimination of hatchery practices that subject fish to unnatural selection pressures.

6. Establishment and continual monitoring of unsupplemented control streams, and the comparison of trends in abundance and genetic indices of supplemented and unsupplemented "subpopulations" within the same stock.

It is important to note that a genetic monitoring and evaluation program will be developed by EDWG to assess the project's central goal of increasing harvest and enhancing long-term productivity without adverse genetic impacts.

HARVEST MANAGEMENT PLAN

A harvest management plan for the YKPP was developed jointly by the WDF, the WDW, and the YIN. Information from the Pacific Salmon Commission, the Pacific Fisheries Management Council, members of the Columbia River Compact, and comments of public interest groups were considered in development of the plan.

The general framework of the plan balances competing needs for tributary harvest, natural stock escapement, genetic resource conservation, and hatchery broodstock. Relatively conservative harvest rates are imposed at low stock abundance to accelerate rebuilding while permitting moderate harvest opportunities for treaty and nontreaty fisheries. The harvest plans also reflect a strong commitment by state and tribal managers to control harvests so natural and hatchery broodstock requirements can be met and to ensure that natural escapements are sufficiently large to permit evaluation of supplementation experiments.

All Yakima and Klickitat stocks are subject to harvest in ocean and in-river fisheries. Present policy suggests that increases in ocean interceptions above current rates are unlikely. Impacts of in-river fisheries on YKPP fish will depend largely on changes in production of other stocks, and whether fisheries continue to be managed for aggregate escapement goals.

Fall chinook salmon and coho are the two primary stocks expected to contribute to ocean and mainstem fisheries. Steelhead do not contribute significantly to ocean fisheries, but will contribute to treaty commercial and non-treaty recreational fisheries in the mainstem Columbia River. The contribution of spring chinook to all ocean fisheries is thought to be less

than 10% of the run and increased production as a result of the YKPP is unlikely to significantly affect mainstem harvest levels. Summer chinook are not expected to be subjected to high rates of harvest in the ocean or the mainstem Columbia River.

The framework for treaty/non-treaty allocation of spring chinook has been developed, and will likely be used for other stocks of interest (i.e., steelhead). Species-specific harvest plans will be implemented jointly by the managers. The managers will also explore and develop methods to forecast stock returns to the terminal areas and develop sampling programs to track the progress of terminal fisheries toward specified harvest goals.

The following text summarizes terminal harvest goals for the eight stocks to be managed under the YKPP.

Yakima Spring Chinook

Only 20% of naturally-produced spring chinook adults may be taken for hatchery broodstock to safeguard genetic resources. Accordingly, the broodstock goal of 970 adults will be met at run sizes exceeding 6,000 fish. Harvest rates are fixed on runs up to 12,000 to obtain a range of escapements above the interim goal.

Yakima Summer Steelhead

Recreational fisheries in the Yakima River are currently designed to harvest most hatchery steelhead, while reserving wild/natural fish for spawning. An incidental steelhead harvest would occur in tribal dipnet fisheries because fall chinook and coho enter the river with summer steelhead. The hatchery broodstock goal of 240 naturally-produced adults will be met at run sizes in excess of 2,525 fish. The interim natural escapement goal of 9,000 adults will be achieved at runs of about 10,250. Terminal harvest rates will be restricted until the interim natural escapement goal is reached.

Yakima Fall Chinook

The broodstock goal of 1,070 will be met at natural escapements greater than 1,780 from runs exceeding 2,250 fish. The interim natural escapement goal of 10,000 adults will be achieved with runs of 13,800. Terminal harvest rates for all fisheries are 20% on runs greater than or less than 13,800.

Yakima Summer Chinook

A harvest management plan will be developed for terminal fisheries as production plans for this stock become more certain.

Yakima Coho

The harvest plan for Yakima coho emphasizes terminal harvest of all coho in excess of hatchery needs. The broodstock collection goal of 2,350 adults will be met regardless of returning run size by importing surplus coho from other hatcheries if harvest and broodstock needs are not met. Terminal fisheries will be managed for 50% harvest rates on runs less then 4,700 and for all harvestable surplus on runs exceeding that number.

Yakima Sockeye

No harvest plans have been developed for this species pending feasibility studies.

Klickitat Spring Chinook

The hatchery broodstock goal of 2,900 adults will be met at run sizes of about 4,150 fish. A natural escapement goal will be agreed upon once better information is available on passage and production potential. Harvest rates for all terminal fisheries will not exceed 30% until the natural escapement goal is met.

Klickitat Summer Steelhead

Recreational steelhead fisheries are designed to harvest most hatchery steelhead while reserving wild/natural fish for spawning. An incidental steelhead harvest will occur in target fisheries on fall chinook and coho. Under YKPP supplementation goals, adipose-clipped steelhead will spawn naturally to rebuild the natural stock to MSY levels. Accordingly, harvest rates on adipose-clipped steelhead will not exceed 55% in all terminal fisheries during the rebuilding phase. The hatchery broodstock goal of 350 adults will be met at natural escapement of 3,500 adults from runs of about 4,100 fish. The interim goal will be reviewed once better information is available about passage and production capacity (by 1992). Terminal harvest rates will be restricted until the interim natural escapement goal is reached.

EXPERIMENTAL DESIGN PLAN

The YKPP will help determine what role supplementation should have in rebuilding production in the Columbia Basin. This help will consist of new knowledge about supplementation benefits, constraints, costs, and procedures. An annual, integrated course of pre-facility planning will continue through 1995 for the Yakima system, when hatchery operation and experimentation are is expected to begin. The pre-facility planning schedule for the Klickitat system will continue through 1997. Implicit communication links in the planning cycle ensure the coordination of YKPP activities with other fisheries research and management groups in the Columbia Basin. These links include regular meetings, external peer-review of products, and participation of members of the YKPP's EDWG in the system wide planning processes (e.g., the Supplementation TWG and the Council's MEG). Although implementation of the experimental plan is envisioned in 5-year cycles, review and modifications, based on experimental results, will occur on an annual basis.

The basic goal of the YKPP is to enhance stocks of salmon and steelhead through hatchery supplementation, but to not create separate hatchery and natural populations with irreconcilable harvest and escapement needs. No less important are the goals of increasing productivity in the Yakima and Klickitat subbasins, and the experimental goal of providing new knowledge of supplementation applicable in other Columbia River tributaries. The success of supplementation is founded on a set of four operating assumptions that are to some degree justified by current knowledge. These assumptions are:

1. Hatchery fish will survive and return to the target spawning areas at rates equal to substantial fractions of estimated natural rates.
2. Supplemented populations will successfully reproduce.
3. Supplemented populations will maintain fitness over the long term.
4. Inter- and intra-specific interactions can be managed to avoid unintended effects.

Hatchery practices must be carefully standardized in order to avoid experimental confounds. Therefore, rigid guidelines for hatchery operations will be developed and observed. It should be clearly noted that hatchery practices are not treated as an experimental variable.

The experimental design is an iterative process using knowledge gained at each step to refine future actions. Each iteration of the experimental program design will involve the following basic steps: identification of critical uncertainties, identification of appropriate response variables, and modification of previous uncertainties and hypotheses based upon results of the experimental program.

The central experimental hypothesis of the YKPP will be evaluated against criteria in the four primary population response categories: 1) post-release survival of hatchery fish, 2) reproductive success of supplemented populations, 3) long-term fitness of supplemented populations, and 4) inter- and intra-specific interactions.

Post-release survival is defined as survival from time of release until fish return to spawn. It is important that post-release survival be high enough that the advantages attributable to artificial incubation and rearing are not offset. Survival within a subbasin of both supplemented and natural smolts has been identified as a critical uncertainty in this category, and is being addressed in pre-facility work at the present time. The standard against which post-release survival will be assessed is the survival of natural fish.

Reproductive success is defined as the number of offspring produced per spawner in a supplemented population. The relative reproductive success of hatchery, mixed ("hybrid"), and natural matings is a critical uncertainty.

In the context of the YKPP, a "fit" population is one that maintains its genetic identity and diversity. The maintenance of fitness of supplemented populations over the long term is a critical uncertainty. In order for fitness to be maintained, existing substocks will be identified and appropriate broodstock collection practices will be developed and implemented.

Species interactions consist of the effects supplemented populations have on a species of interest. Measurable components of species interactions include population abundance and distribution, growth rates, carrying capacity, survival rates, and gene flow. In particular, interaction between supplemented populations of steelhead trout and resident rainbow trout has been identified as a critical uncertainty.

A monitoring program is being developed to measure responses of salmonids in the Yakima and Klickitat subbasins to supplementation activities. Responses are measured in terms of survival by life stage (post-release survival), reproductive success, long-term fitness (genetics monitoring), and interaction effects. The response variables that must be measured include:

- Survival of fish from release through outmigration.
- Contribution to major fisheries.
- Adult returns to the subbasin.
- Spawning.

Development of appropriate methods for monitoring these characteristics is a primary goal of the pre-facility experimental program. Response variables for studies of the genetic effects of supplementation, intra-specific and inter-specific interactions, and stock assessment must be identified and coordinated within the monitoring program. Sampling rates, locations, schedules, and procedures will be further refined as current baseline data collection studies provide more information and as research needs are further refined.

PRELIMINARY ENGINEERING WORK PLAN

Preliminary design studies were conducted to provide plans for construction of salmon and steelhead facilities in the Yakima and Klickitat subbasins. These studies will guide TWGs and design engineers in final project design and construction. The nature and location of various fish-production facilities were consistent with the Yakima and Klickitat Rivers Central Outplanting Facility Master Plan, and the Report on Refined Project Goals and Management Plan for the YKPP. Participants in planning included BPA, the YIN, the WDW, the WDF, the U.S. Bureau of Reclamation (USBR), outside experts in fish hatchery design/culture, and the consulting engineers. Specific production goals and other requirements were developed with input from the EDWG.

Water quality guidelines used for YKPP fish culture facilities were originally developed by the Alaska Department of Fish and Game. Disease control criteria were incorporated into hatchery design, and addressed methods

and facilities for incubation, rearing, and adult holding. Flow rates were estimated from calculations on flow and space requirements by species. These flow rates were compared with available flows as reported in the Water Analysis Report.

The programming of each fish species by subbasin and facility was accomplished with the help of a computer program developed by Fish Management Consultants (FMC). This program calculates space, flow, and food requirements for the fish culture activities. Programming was based on a discrete number of experimental groups per targeted stock. Fish production schedules and the requirements for rearing and incubation of experimental groups were coordinated and carefully reviewed. Facilities were designed to accommodate all phases of the life-cycle of targeted stocks, including adult holding and spawning, incubation of eggs, rearing, food consumption, fish transportation, and manpower.

The Cle Elum site was chosen as the central hatchery facility for upper Yakima spring chinook. In addition, Naches spring chinook eggs will be moved from Oak Flats to this site after they reach the eyed stage, and will be incubated and reared here until being returned to Oak Flats as fingerlings. The Oak Flats site was chosen as the central hatchery facility for Naches spring and summer chinook, and all coho production. Some steelhead rearing will also occur on this site. The Nelson Springs central hatchery is located at the confluence of Buckskin Creek and Nelson Springs, and was selected as the central hatchery for fall chinook and summer steelhead. The Nelson Springs site will provide for adult holding, incubation, and rearing of summer steelhead and fall chinook.

Fifteen acclimation ponds in five clusters of three each were described for upper Yakima spring chinook in the plan developed by EDWG. The plan for acclimation of the Naches spring chinook included three clusters of two ponds each. The plan developed for summer steelhead includes six clusters of two ponds. A standardized acclimation pond was designed to accommodate the various experimental groups in the program.

The Klickitat facility is designed to meet the hatchery goal of enhancing spring chinook and summer steelhead. Cascade Springs is the planned

location for the central facility and will include operations for adult holding, spawning, egg incubation, rearing, and acclimation and release. Five alternative sites were considered for some form of facility development: White Creek, Summit Creek, Klickitat WDF Station, Wonder Springs, and Indian Ford Springs, Acclimation sites in the upper Klickitat subbasin may receive fish from the central facility for short-term holding and rearing prior to release. Potential sites for "trap-and-haul" programs include the Falls 5 Fishway, the WDF Klickitat Hatchery, and the Castile Falls Fishway. Water for the Klickitat Hatchery will come from three sources: Cascade Spring, Kidder Spring, and the Klickitat River.

PROJECT COST ESTIMATE

Total costs for the Yakima and Klickitat projects through March 1, 1990, were about $8,400,000. This value includes costs through FY-90 ($6,186,000) and current obligations for FY-90. The total costs estimated for construction of the Yakima River subbasin salmon and steelhead facilities (i.e., central hatcheries, satellite facilities, acclimation sites, adult and juvenile trapping facilities) is $31,434,000. An additional $500,000 has been estimated for land acquisition for the three central hatcheries and the two satellite sites. Land acquisition costs are not yet available for the acclimation sites or the adult and juvenile trapping facilities. The total cost for construction of the Klickitat facilities, including five acclimation sites and fees for design and construction engineering, legal, and administrative fees is estimated to be $9,040,000.

ANALYSIS OF WATFR SUPPLIES

The USBR conducted an analysis of the adequacy of water supplies in the Yakima and Klickitat subbasins for increasing natural and artificial production of anadromous salmonids. This analysis, which was based on literature review and field studies, emphasized the following four areas:

1. Water quality and quantity for the proposed artificial production facilities and for mainstem reaches and tributaries supporting anadromous fish.
2. Accessibility and quality of existing anadromous fish habitat.

3. Existing constraints on anadromous fish production.

4. Classification of streams into three mutually exclusive production categories: currently suitable for anadromous production, suitable for anadromous production in the near term (less then 10 years) with improvements or new water use agreements, or unsuitable for anadromous production in the near term.

The water for instream flows in the Yakima River and for irrigation in the Yakima Valley is supplied by natural flows, groundwater, storage, and return flows. Instream flows are affected by storage reservoir operating schemes, irrigation diversions, irrigation return flows, hydroelectric plants, and pumping plants. Reservoirs provide storage water to irrigation districts, and return flows from irrigation systems in the upper valley provide much of the instream flows in the lower Yakima River during the irrigation season. In contrast, no major storage reservoirs have been constructed in the Klickitat subbasin and total diversions represent a small fraction of total runoff. It is not thought that instream flows limit anadromous fish production in the Klickitat subbasin because the runoff pattern is essentially natural.

The water supply analysis study team compiled data from five general areas: stream hydrology, stream description, facility water supplies, fish habitat, and water quality. Summary and analysis of streamflows was based on historic data, field measurements, and computer simulations of the Yakima River storage system. Information on fish habitat quantity and quality included data from instream flow methodology (IFIM analysis), descriptive field surveys, and information summarized in the Yakima and Klickitat Subbasin Plans. Estimates of the natural production potential of anadromous fish habitat in both subbasins were made using the standard smolt density method employed in subbasin planning.

Central hatchery facilities have been proposed for five sites in the Yakima subbasin (Prosser, Wapato Canal, Cle Elum, Oak Flats, Nelson Springs) and one site in the Klickitat subbasin (Cascade Springs). The quantity of surface water available is probably adequate for all sites. Groundwater supplies need additional development at three of the sites. Water quality parameters of some concern included temperature, metallic ions (especially

aluminum), chloride and nitrates. However, natural production does not appear to constrained by water quality.

Existing conditions in the lower Yakima River--the 47 miles from Prosser Dam to the Columbia River--could affect the production of all five stocks of salmonids to some degree, while conditions in tributary streams could affect one to four stocks. Except for the Naches system, no tributary of the Yakima River presently has the instream flows, accessibility, and habitat quality to realize its full production potential. Flow constraints are numerous and include low spring flows in the upper Yakima River that directly or indirectly kill newly-emergent fry; low spring flows in the middle river (below Sunnyside Dam) that exacerbate losses of outmigrating smolts; low winter flows in the Yakima Canyon that adversely affect overwinter survival; and summer flows throughout most of the drainage that are too high for optimal rearing. Potential water quality constraints include high temperatures in the lower river that could prevent passage and rearing, as well as elevated concentrations of chloride, nitrate, and metallic ions such as aluminum and manganese. However, these water quality problems are largely restricted to the lower river (specifically, the reach from Sunnyside Dam to the Columbia), and it is only in the lower river that they constrain the production of anadromous fish. Passage problems include adult migration barriers (primarily at impassible diversion dams on tributaries), hazards to juvenile migration (primarily in the form of unscreened or poorly screened irrigation diversions), and regions of low streamflow below larger irrigation diversions that impair passage of both adults and juveniles in several tributaries as well as the mainstem Yakima River. Most of the constraints to anadromous fish production in the Yakima subbasin can be reduced or eliminated with improvements.

There appears to be adequate streamflow and spring water quantities at the Cascade Springs site in the Klickitat subbasin to meet the projected fish facility needs. However, further investigation of the effects of elevated levels of metals in the river water on fish culture at the site is needed. The major constraints to anadromous fish production in the Klickitat subbasin are adult passage and flow. The two major passage problems in the mainstem are Lyle Falls (river mile 2.2) and Castile Falls (river mile 64.2).

Steelhead, spring chinook, and coho are the primary stocks affected. Several falls block access to tributaries in the Klickitat River. Low seasonal flows also restrict rearing of anadromous fish in a number of tributary streams. Most tributaries in the Klickitat subbasin are not suitable for supplementation because of limited production potential. Water quality (i.e., sediment loading) is a problem in the Klickitat River downstream of the Big Muddy Creek confluence at river mile 53.8. Provision of adult passage facilities at Lyle and Castile Falls was identified as improvement projects with the largest potential of increasing anadromous salmonid production in the Klickitat subbasin.

In 1989, the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), and the YIN began investigations to determine the incidence and geographic distribution of significant salmonid parasites and pathogens that could affect the, proposed supplementation program. The presence of some common salmonid pathogens has already been established within the Yakima and Klickitat watersheds. However, the tribe and agencies will use the latest and best available husbandry and disease prevention techniques in attempts to minimize mortality from fish diseases. Several operational plans have been designed to reduce the impact of infectious diseases, including vaccination of broodstock, separate incubation of egg batches, and isolation of water supplies during holding periods. Fish husbandry and health practices recommended by the Pacific Northwest Fish Health Protection Committee (PNFHPC) will be followed and activities coordinated with the WDF, the WDW, and the YIN to assure that all fish and gametes brought into the subbasins and/or released from central outplanting facilities meet state standards designed to reduced the incidence and spread of disease.

GENETIC RISK ASSESSMENT

A preliminary genetic risk assessment was conducted for the YKPP by the WDF. The document follows many basic concepts for genetic risk assessment currently being developed by the Council's MEG, but will be revised as risk assessment tools and a standard format become available. A fundamental informational need for genetic risk assessment is knowledge of the substock structure of target species and runs, and this information is not yet

available for the YKPP. Extensive sampling of chinook and steelhead in both subbasins for substock identification research began in 1989. YKPP operations will be revised as information from direct experimentation or from population sampling becomes known.

Current'genetic risk assessment planning by the MEG has identified three types of genetic risk: 1) extinction, 2) loss of within-population variability, and 3) loss of population identity. Extinction is the most extreme type of risk and can be caused by any activity that reduces a population below a minimum viable level. Loss of within-population variability is commonly associated with hatchery production. Type 2a risk is loss of variability due to genetic drift and is the most common type of genetic risk imposed by hatcheries. Type 2b risk is loss of variability due to non-random sampling of a population in collecting broodstock and can also occur in hatchery populations. Loss of between-population variability or loss of population identity happens when stocks are mixed during broodstock collection and egg taking, or if straying occurs. Domestication selection is a fourth type of genetic risk that needs to be considered in assessing the impact of hatchery operations on salmon and steelhead.

Genetic risk can be minimized by careful management of fisheries and hatchery operations. The risk of extinction can be minimized by managing for terminal harvest. Weak substocks can be protected by restricting terminal harvests in the light of various indices of substock abundance, such as coded-wire tag recoveries or genetic stock identification (GSI) data. The key to controlling loss of within-population variability is an accurate estimation of effective population size. Random collection of fish for broodstock will help to limit loss of variability due to "founder effects." Loss of population identity can be minimized by determining the geographic distribution of targeted stocks, and by restricting outplants to ancestral areas. Domestication selection can be minimized by reducing or eliminating hatchery practices that impose artificial selection pressures.

The commitment of YKPP planners to minimizing genetic risk is illustrated by the fact that the entire project is designed as an experiment, the central'hypothesis of which is " . . new artificial production in the Yakima and Klickitat subbasins can be used to increase harvest and to enhance

natural production without adversely affecting genetic resources." Thus, certain genetic conservation protocols are built into the YKPP.

Substock identification has been identified as a critical YKPP pre-facility research activity. The intent is to characterize electrophoretic and scale patterns for all major spawning aggregations of pre-existing stocks targeted for supplementation. This includes spring chinoook and summer steelhead in the Yakima and Klickitat Rivers, and fall chinook in the Yakima River. Klickitat winter steelhead will also be sampled.

Broodstock management will be designed to minimize genetic risk. Returning adults will be taken randomly at appropriate collection sites, and effective population size will be maximized in the hatcheries.. Caps will be set on the maximum proportion (of annual run size) of discrete stocks that can be collected for broodstock. Stock mixing in the hatcheries will be eliminated by culturing different stocks in separate containers. All hatchery reared fish will be marked and excluded from broodstock collections to minimize risk of domestication selection. Development of improved broodstock management techniques has been designated a critical pre-facility need.

Long-term monitoring is required to assess the success of the genetic conservation effort. YKPP stocks will be periodically reanalyzed electrophoretically to examine genetic change at structural gene loci over time. Observed gene frequency fluctuation in supplemented populations will be compared with theoretical values based on the effective population size of the natural population. Detailed fitness comparisons between hatchery and wild fish will be based on measurements of several survival and reproductive traits.

American River spring chinook and Satus Creek summer steelhead will not be supplemented because they have little or no hatchery ancestry and, in the case of American River spring chinook, because they represent a genetic type unique in the Columbia Basin. Thus, Satus Creek and the American River will be managed as "genetic refuges" for these two stocks. Management may eventually include construction of weirs across the streams to restrict entry of strays.

Genetic risk assessments are provided in the predesign report for targeted stocks as well as for nontargeted stocks that may be genetically impacted. Discussion of non-target stocks is limited to rainbow and cutthroat trout. Other fish populations which do not interbreed with YKPP production stocks, but which may be displaced, are not discussed.

ECONOMIC ANALYSIS

The proposed YKPP will have major impacts on the economies of the project area. During the construction phase economic flows will arise from spending on materials, services, and labor. Upon completion of this phase of the program, expenditures associated with sport and treaty harvests will cycle through the local economies. A biological monitoring and experimentation program will also generate employment, spending, and income. Yakima and Kittitas Counties will experience the greatest economic impact because of the size and type of proposed hatchery facilities in the region, the size and nature of the local economies, and the interaction of economic flows.

A computer model of the local economies was used to simulate local economic interactions. Two complementary methodologies were used to estimate indirect and induced impacts of the YKPP. A modified version of IMPLAN (IMpact analysis for PLANning) model was initially used to simulate the linkages among the various industrial and commercial sectors of an economy. Impacts were developed for the construction and harvest time periods, and for each of three economic areas: the total project area, the Yakima subbasin, and the mid-Columbia/Klickitat subbasin. A regional econometric model was used to quantify the key linkages between employment, income, and spending in a region. The magnitude and extent of these linkages was estimated using historical data on the operation of the regional economy.

For the economic analyses, the program was divided into four major elements: construction, operation and maintenance, experimentation and monitoring, and harvest. Different estimation procedures were developed for the direct impacts stemming from each of the four categories of fishery enhancement activities. Construction expenditures were allocated into specific industrial sectors and assigned to specific counties and years, Broad measures of aggregate project spending were allocated to industrial

sectors and specific counties to obtain direct expenditures resulting from operations, maintenance, and experimentation and monitoring. Direct expenditures resulting from harvest activities included both sport fishing and treaty fishing components.

The project was estimated to develop 6,975 person-years of employment, $132,424,280 of income, and $33,859,760 of taxable sales in the study area from 1990 through 2015. In a typical year during the construction phase, the study area was estimated to experience increases of 143 jobs, $4,036,856 in income, and $8,753,135 in output. The construction sector will experience the greatest change in output, whereas the service sector will experience the greatest increase in income and employment. In a peak harvest year, the study area will experience an estimated increase of 409 jobs, $8,507,806 in income, and $17,627,154 in output. The service and trade sectors are estimated to account for 82% of these changes.

An overall increase in total economic activity will be brought about by the YKPP. Timing of peak impact events include a construction period impact peak occurring in 1994, a harvest impact peak in 2015, and a slight dip in regional economic activity commencing in 1995 and ending with the third year of harvesting in 2000. A level of economic activity is expected to be 2.8 times as great in the peak harvest year as in the peak construction year,

Anticipated benefits include increased employment in areas generally suffering from high unemployment, stimulation of entrepreneurial activities in the study area, and a relatively steady increase in jobs and income. The new jobs will bring a mixed quality of employment to the region--high income employment will be associated with the construction, operations and maintenance, and experimentation and monitoring phases, while lower income employment will occur from service sector and trade activities during the harvest period.

The project is also predicted to aid in the structural evolution of the study area's economy. For example, gradual changes in sport fishing will induce increases in tourism. This shift into tourist-related activities will represent a new undertaking for much of the region. Examples of new

enterprises include marinas, tackle sales, guide services, and traditional hospitality industries.

A relatively steady building of jobs and income will occur because of the existence of continued operations and maintenance expenditures, and because the experimentation and monitoring expenditures will help balance reductions of construction expenditures. The addition of Phase II screening and enhancement construction will help to smooth the transition from hatchery construction activities. Additionally, increases in service sector activities during experimentation and monitoring will modulate impacts of the strong service sector that are expected during the harvest period.

ENVIRONMENTAL ASSESSMENT

The BPA prepared an Environmental Assessment (EA) in March 1990 for the YKPP as required by the National Environmental Protection Act (NEPA). The draft EA of June 1989 was submitted to the public for review and comment. The EA included several alternatives, including BPA's proposed action and a "no action" (i.e., no project will be built) alternative. The major issues of concern in the draft EA included potential effects of supplementation on resident trout populations in the upper Yakima River and on genetic diversity of existing stocks, effects of hatchery operations on water rights and water quality, and potential impacts of construction activities on important habitat (i.e., wetlands), sensitive wildlife species, and/or cultural resources. The EA provides a detailed analysis of these and other issues. Recommendations were made that included further monitoring and evaluation, identification of mitigation measures, and/or development of alternative locations for project implementation. The current enhancement scenario for the YKPP was based on the EA, the results of the engineering feasibility study, experimental design, and baseline data.

I. INTRODUCTION

The purpose of this report is to summarize progress made on work for the YKPP. A master plan for the YKPP was developed by the Council on October 15, 1987, as a reasonable basis upon which the BPA could proceed to fund predesign work on the project. The Council approved the predesign work on the condition that the following tasks were included:

Task 1: Agree on a refined statement of project goals (Sec III A).
Task 2: Conduct a technical analysis of water supplies (Sec IV A).
Task 3: Complete experimental features of the project (Sec III B).
Task 4: Develop a plan for harvest of the new production (Sec III A 3).
Task 5: Assess potential genetic risks (Sec IV B).
Task 6: Coordinate with others (Sec II A).
Task 7: Report to the Council (this document).
Task 8: Develop a project management structure (Sec II B).

This preliminary design report (Task 7) summarizes the work performed for each task and addresses specific elements of the Council's predesign study description (letter of November 10, 1987; M. Brusett to J. Jura) and the Council's staff issue paper on the YKPP (NPPC 1987). Additional summaries are provided for the preliminary design, engineering, and construction phases of project development and for estimated project costs, including costs incurred to date. A summary of economic benefits and the environmental assessment is also provided. More detailed descriptions of studies in support of the Council's tasks and related information are attached as Appendices A through D. Changes in the preliminary design studies are anticipated following public review and prior to final design, engineering, and construction.

The results of studies conducted during the last 30 months indicate that hatchery facilities can be built in the Yakima and Klickitat subbasins to provide additional harvest benefits, to supplement natural production, and to gain knowledge that will benefit the region. Planning for the Yakima subbasin is at a more advanced stage of development than the Klickitat subbasin because of greater availability of basic resource information. The information needed to proceed with final design and construction for the Klickitat subbasin will

be in hand by 1992, as ongoing predesign work continues. Thus, some task elements for the Klickitat subbasin will be dealt with on a site-specific basis after additional information is gathered and analyzed.

Both the Yakima and Klickitat subbasins are located in southcentral Washington State, but drain into the Columbia River from different watersheds (Figure 1). The 200-mile-long Yakima River drains approximately 6,000 square miles of the eastern slope of the Cascade Mountains. It originates at Lake Keechelus in the Cascade Mountain range and flows through vast, semi-arid prairie and gently rolling grass-covered hills into the Columbia River near

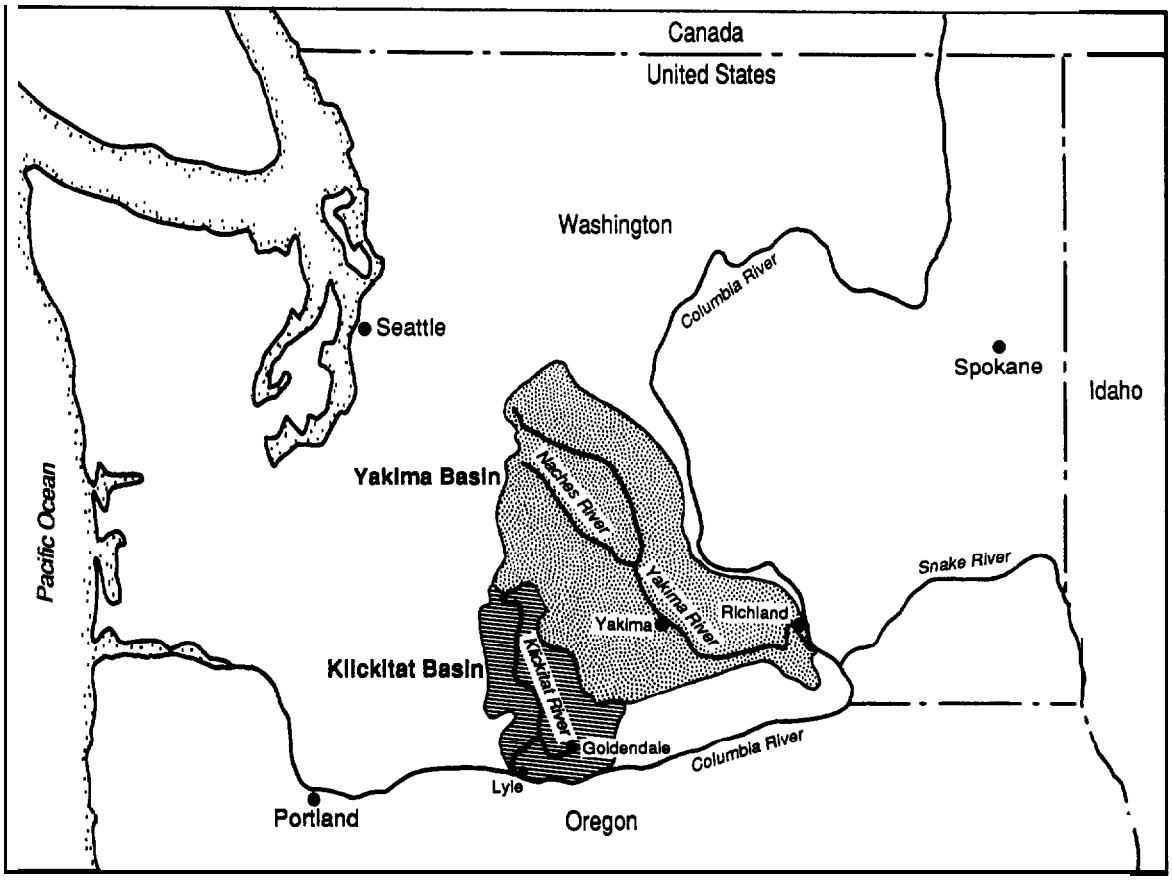


FIGURE 1 Map of the Project Area

Richland, Washington. The 95-mile-long Klickitat River lies about 80 miles to the west and drains about 1,200 square miles of the east slope of the Cascade Mountains. From its origin at Tieton Peak, the Klickitat River passes through the western edge of the Yakima Indian Reservation and joins its main tributary, the Little Klickitat River, before entering the Columbia River at Lyle, Washington.

The proposed Master Plan for the YKPP (FMC 1987) provided the conceptual framework for the project. It described the types and numbers of fish that may be produced, how they will be produced, and the kinds and locations of facilities. It also included a description of management policies and procedures, funding and construction schedules, and steps for evaluating the success of the effort. Three general types of facilities are planned for the YKPP. Central hatchery facilities will be built in each subbasin for adult holding, egg, incubation, and juvenile rearing. Clusters of ponds will be constructed in stream reaches targeted for supplementation, where juvenile fish will be held prior to release. Adult and juvenile trapping facilities exist in the Yakima River, and additional facilities will be built in both subbasins. They will be used for brood stock collection as well as for sampling and monitoring of upstream and downstream migrants.

The following section (Section II) discusses the process whereby the YKPP plan was developed, how this development continues, and how the future management of the project is envisioned. Section III provides a summary of the YKPP plan, including the Refined Project Goals, the Experimental Design Plan, the Salmonid Health Plan, and the Preliminary Engineering Work Plan. In Section IV, the Water Supply Analysis, the Genetics Risk Assessment, the Economic Analysis, and the Environmental Assessment are discussed.

II. PROCESS AND PROJECT MANAGEMENT

A. COORDINATION AND CONSULTATION

Extensive coordination is required for this project because of the complexity of the technical issues, the number of public and private interest groups involved, and because of the wide geographical area over which the project encompasses. Accordingly, BPA has developed a number of coordination and consultation activities that range for the project. For example, BPA has developed a Public Involvement Plan to involve interest groups and individuals in the Yakima and Klickitat subbasins with project planning.

The public information/involvement process addressed in the plan encompasses all project development, including the predesign, final design, and construction phase. Each phase includes a variety of public information/involvement activities from one-on-one consultations to large group public meetings designed to assist decision making and lead into the next phase of the project. The BPA's public information/involvement plans revolve around "decision points" or times when information is assembled and evaluated before the next phase of the project is initiated. Interested parties are then provided the opportunity to comment before decisions are made. The Public Involvement Plan also includes inputs from TWGs.

The YIN has appointed a tribal project manager to interface with the BPA project manager and the project leader. The project leader represents the fishery management entities of the state and tribe. The YIN project manager develops reports monthly that summarize prior activities and describe future plans for task teams and management entities involved in the YKPP. The project TWG meets monthly to review the technical progress and to recommend action or submit questions to the project managers and various task teams. The task teams, units of the TWG, are responsible for progress in the following areas: coordination (of all project activities), water analysis, tributary issues, experimental design, disease strategies, engineering, environmental, and sockeye feasibility. Task team efforts are coordinated with the systemwide TWGs, specifically the MEG, the Supplementation TWG, the HE-TWG, and the Fish Health Protection Committee. Representatives from various Council groups coordinate TWG issues with their respective task teams.

The EDWG provides coordination for the biological aspects of the YKPP. This coordination role includes assuring consistency between project goals and scientific activities, establishing standards for experimental design and data analysis, and communicating biological requirements to the management entities and technical groups. The EDWG is also responsible for coordinating YKPP research activities with other fishery programs within the Yakima and Klickitat Basins and system-wide within the Columbia Basin. Monthly meetings of the YKPP TWG include status reports from EDWG. Review of EDWG products by TWG members are solicited along with appropriate external peer review. Final drafts of annual planning documents also are submitted to the YKPP policy group comprised of representatives of the WDF, the WDW, and the YIN.

Specific groups where coordination activities are involved include:

- System planners. Development of the system and subbasin plans for the Yakima and Klickitat include YIN biologists to assure that objectives are consistent with the YKPP.
- Hatchery managers. This project may use other hatcheries as temporary or long-term sources of brood stock. For example, broodstock for both the experimental sockeye and summer chinook programs will be collected at Dryden Dam in the Wenatchee Basin. Spring chinook are currently being produced at WDF's Klickitat Hatchery and future production plans will be integrated with those of the YKPP. Thus, the production plans for these and other stocks have been reviewed by hatchery managers to ensure that adequate numbers and disease-free brood stock will be available for supplementation activities.

Related Production Planners. Other activities in the Columbia basin may affect production goals of the YKPP. Although the goals of these activities (i.e., John Day mitigation) are separate from those of the YKPP, they need to be considered in planning efforts. For example, all activities associated with the John Day Program in the Yakima Basin will be under the jurisdiction of the YKPP. This concludes the coordination of rearing and release of upriver bright fall chinook from acclimation sites in the lower Yakima River.

- Irrigation and Water Enhancement Planners. An analysis of water supplies was conducted for the YKPP by the U.S. Bureau of Reclamation (USBR, Appendix B). This study drew upon information previously collected by fishery managers, irrigators, USBR, Washington Department of Ecology (WADOE), and others. The report included a summary of existing sources of water and an assessment of both water quality and water quantity for fish production and complements the Yakima River Basin Water Enhancement Project Study conducted by the USBR and WADOE. Any additional fish production associated with a water enhancement project will be coordinated with the YKPP to ensure complementary objectives and operations. Other activities include coordination with the USBR System Operations Advisory Committee.

  Harvest managers. Terminal fisheries in the Yakima and Klickitat Rivers are cooperatively managed by the WDW, the WDF, and the YIN. A framework for treaty/nontreaty allocation of salmon 3and steelhead is being developed for spring chinook and can be applied to other stocks of interest. (see Refined Goals and Harvest Management Plan, Appendix A). Coordination with the Pacific Salmon Commission and the Pacific Fishery Management Council (PFMC) is also required because fish produced in the Yakima and Klickitat Basins will contribute to both in-river and ocean fisheries. The Harvest Management Plan developed for the YKPP considers harvest sharing guidelines and stock enhancement goals given in the Columbia River Fish Management Plan for mainstem Columbia River fisheries.

- Monitoring, Evaluation, and Research Groups. YKPP activities are coordinated with data collection efforts by the Pacific Salmon Commission, under the auspices of the U.S./Canada Pacific Salmon Treaty. The EDWG also coordinates with the Council's MEG and the Columbia River Basin Fish and Wildlife Authority's Supplementation TWG to insure that YKPP research, monitoring, and evaluation activities are consistent with those throughout the basin. Coordination with the Supplementation TWG ensures that project objectives are consistent with the 5-year supplementation research work plan. The Pacific Northwest Fish Health

Protection Committee (PNFHPC) has also been contacted to provide assistance on matters related to disease prevention and control.

- Other Interest Groups. The formal coordination process with the general public began with meetings in Ellensburg, Yakima, Goldendale, and Rlchland in March 1988. The coordination task team received comments and answered questions on a broad range of fishery and irrigation issues. Meetings with landowners, sports groups, irrigation districts, units of local government, and others continued throughout the summer. The primary emphasis was on fish production in Yakima Basin tributaries. Workshops and meetings with sport fishing groups have also been held. Coordination activities with sport fishing groups dealt primarily with concerns regarding potential impacts to rainbow trout above Roza Dam and on distinctions between wild and hatchery stocks of steelhead in the Klickitat River. The EDWG has since developed a study design to investigate potential impacts resulting from interactions between resident rainbow trout and steelhead. This study will be conducted by the WDW in cooperation with the YIN and results incorporated into the basin plan for stock management and supplementation. Coordination activities were also initiated with individuals that own land containing tributary streams. A task team was established to meet with landowners to identify impacts to salmon and steelhead production in various tributary streams. Required improvements and agreements needed to improve production were identified for streams with production potential.

Various newsletters have been produced on the YKPP by BPA and the management entities. Feature articles in the Yakima Basin Resource News and the BPA Backarounder were distributed to the public and these articles provided background information on the project and current status of planning efforts. The BPA has also produced several videos for public information. All interested and affected parties have had open access to the project in all phases of the planning process.

B. PROJECT MANAGEMENT STRUCTURE

The Council has concluded that a project management structure is needed to define clearly the goals of this project, to determine how to measure project successes and failures, to provide for early warning of problems, and to decide how and when changes should be made. The management structure should be prepared to oversee the project from its early stages of development through its long-term operations.

1. Project Manaaement

The Bonneville Power Administration (BPA) is serving as the overall project manager with the responsibility for schedules, contracts, and submitting the preliminary design report to the Council (Figure 2). The project is managed from the BPA Yakima Project Office in Yakima, Washington,

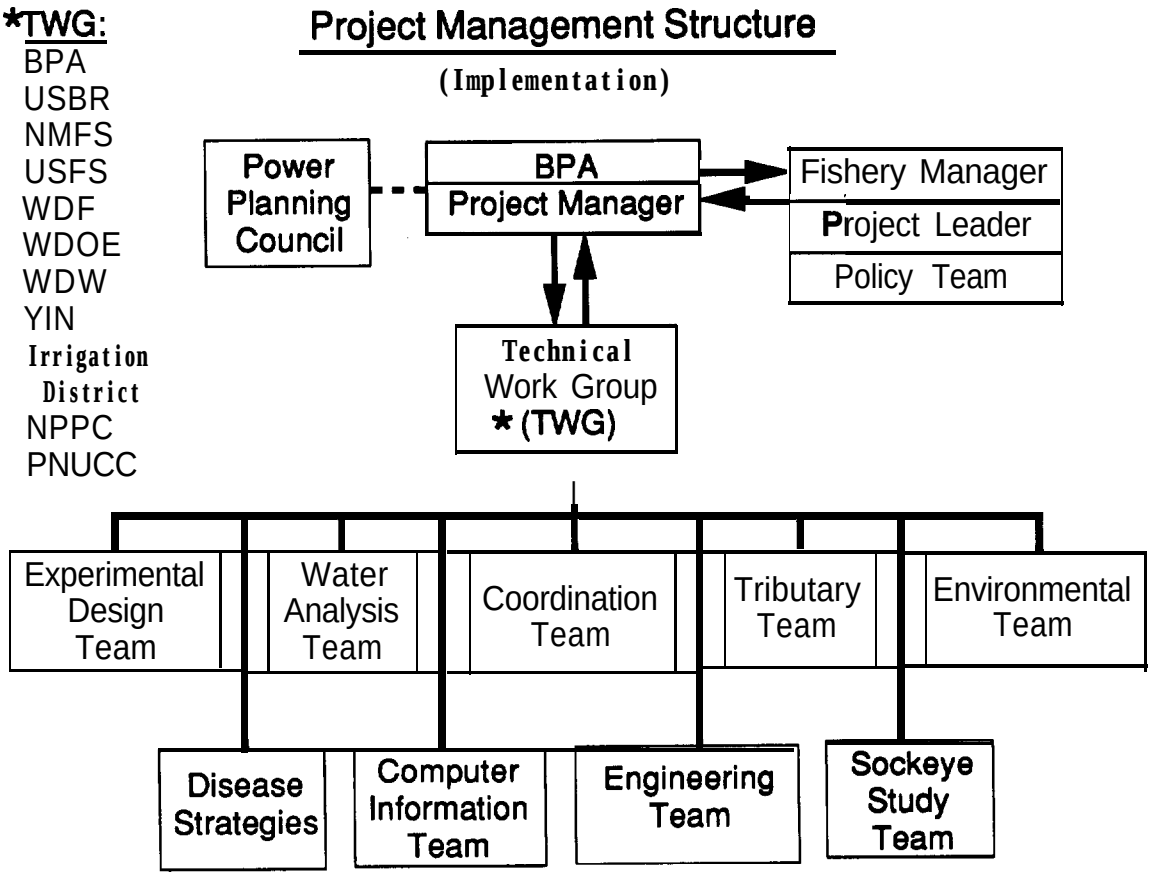


FIGURE 2. Project Management Structure

BPA began funding the preliminary design effort in late 1987, upon completion of the hatchery master plan. In addition to the elements requested by the Council, BPA is conducting the preliminary design of trapping, holding,incubation, rearing, and acclimation facilities. BPA is also continuing the sockeye feasibility study at Cle Elum Lake.

2. Fisheries Manaaers' Leadershio

In late 1987, the fisheries managers nominated a project leader to coordinate efforts of the fishery managers on behalf of the management entities, and to identify policy issues requiring resolution by the appropriate decisionmakers. The project leader function has been funded by BPA since 1988.

3. Technical Advice

A YKPP TWG was formed in late 1987 and is composed of experts in hatchery production, natural production, harvest management, and fish health. TWG members also serve on other system work groups such as the System Operating Advisory Committee, the MEG, the Fish Health Protection Committee, the HE-TWG, the Supplementation TWG, and the Subbasin Planning Group. The YKPP TWG is further split into task teams which provide technical guidance in specific areas (Figure 2).

4. Facilities Manaaement

The BPA and the fishery managers have been working to define the requirements for a facilities manager. This effort included a management analysis study conducted by the Administrative Design Team at Portland State University (PSU). The PSU study included an analysis of group exercises directed at defining and reaching agreement on organization objectives and tasks, and interorganizational relationships. The study was in response to a Council request for an analysis of the administrative arrangements necessary to implement an adaptive management strategy for supplementation of fish runs in the Yakima and Klickitat subbasins.

5. Policy Oversight

The fisheries managers have created a policy-level review group comprised of representatives of the YIN, the WDF, and the WDW. This group

resolves policy issues which relate to production, harvest, and genetics, as well as policy issues identified by the TWG. Policy-level attention will be required for the life of the project.

6. Future Management Structure Considerations

The present project teams will be required for an indefinite period of time. The TWG, task teams, and policy team will have to monitor hatchery practices, evaluate data collected from ongoing investigations, and provide input to the facilities operators and fisheries managers for future operations. BPA will enter into operations and maintenance agreements when an appropriate entity has been identified. The management entities of WDF, WDW, and YIN, working with the PSU Administrative Design Team and BPA, will develop a structure for facilities operation and management that will ensure the integrity of the project in terms of its projected goals and experimental design plan. It is anticipated that this structure will be in place prior to the development of an Operations and Maintenance (O&M) Agreement and should be completed by early 1992.

III. THE YAKIMA/KLICKITAT PLAN

A. REFINED PROJECT GOALS

Task One of the Councils conditional approval of the YKPP was to agree on a refined statement of project goals that were consistent with the project purpose. These goals were to be developed and agreed upon by the YIN, WDF, and the WDW. This chapter summarizes the goals established by those cooperating entities. Additional detail is provided in the Report to the Northwest Power Planning Council on Refined Project Goals and Harvest Management Plan for the Yakima/Klickitat Production Project (see Appendix A).

The purpose of the project as stated by the Council is "...to test the assumption that new artificial production in the Yakima and Klickitat subbasins can be used to increase harvest and enhance natural production while maintaining genetic resources." In establishing the goals and objectives covered in this report, the managers endorse the adaptive management policy adopted by the Council for the YKPP. This approach recognizes that achievement of stated objectives is subject to uncertainty and that flexibility with respect to strategies must be accommodated.

The purpose of the YKPP is to supplement and enhance natural production of salmon and steelhead stocks in the Yakima and Klickitat subbasins, not to replace natural production with hatchery-reared fish. Accordingly, spawning and rearing habitat should continue to be protected and enhanced to maximize natural production. The Yakima and Klickitat Subbasin Plans focus on habitat enhancement in a general sense. YKPP programs are fully compatible with these subbasin plans, but do not assume or require that they be implemented. It should, however, be noted that any measure, including those in the subbasin plans, that enhances natural production will increase the effectiveness of the YKPP.

The YKPP is intended to enhance existing stocks while maintaining their basic character, adaptability, and fitness. The best adapted stocks will be introduced in cases where the target species is no longer present. In order to achieve a successful outplanting program, a set of critical uncertainties must be addressed through an experimental program designed specifically for

this purpose. The areas of uncertainty having the highest priority for supplementation research in the Yakima/Klickitat subbasins have been identified. They concern the effects of a set of supplementation strategy alternatives on: 1) post-release survival of hatchery-reared fish, 2) homing and'reproductive success of supplemented populations, 3) genetic implications including long-term fitness of supplemented populations, and 4) inter- and intra-specific interactions (including competition and other consequences of habitat constraints). Some factors affecting these uncertainties will be experimentally manipulated and the results monitored and evaluated. Factors not varied experimentally will be held constant by quality control and monitoring programs. As hatchery practices are not among the most critical of uncertainties, they will be managed as experimental constants.

Production plans for all stocks in the Yakima and Klickitat subbasins incorporate elements of supplementation where some portion of the returning adults from each stock will be used as hatchery broodstock. Hatchery-produced offspring will be outplanted in areas to which they will be expected to return and spawn naturally. Broodstock selection methods will vary among stocks depending on stock status, productivity, genetic considerations, and management emphasis.

The YKPP includes eight different stocks: spring, summer, and fall chinook salmon, coho salmon, sockeye salmon, and steelhead trout in the Yakima subbasin; and spring chinook salmon and steelhead trout in the Klickitat subbasin. Supplementation objectives vary and range from stocks where natural production is emphasized (Yakima spring chinook) to stocks where hatchery reared fish are expected to provide for most of the production (Yakima coho). Best available hatchery practices will be used in the production of all the stocks cultured as part of the YKPP. These include standard methods used in adult collection and holding, spawning, egg incubation., juvenile rearing, and release. Brood stock policies vary by stock and are designed to address both genetic and disease considerations.

1. Project Goals

The project goals fall into three general categories: productivity enhancement@, stock status enhancement, and experimental goals. A YKPP goal is

to increase production and harvest potential by increasing the number of adults produced per spawner in supplemented populations. Overall productivity will be enhanced by a sustained increase in the juvenile survival rates of that portion of the supplemented population benefiting from artificial incubation and rearing. A concurrent goal is to increase stock status to a level permitting an "Optimal Sustained Yield" (OSY), which approaches the classic concept of "Maximum Sustained Yield" (MSY). Management for OSY generally entails relatively lower exploitation rates and sustainable surplus production than MSY management.

The experimental goal of the project is to design and conduct experiments so that critical uncertainties regarding supplementation are resolved with high certainty. The EDWG will develop and regularly update an experimental plan for the project. Implementation of an effective information sharing system will help make new knowledge available to decision makers within the Yakima/Klickitat subbasins and to managers, researchers, and others in the Columbia Basin.

2. Genetics Considerations

A major element of this project is the conservation of genetic population characteristics currently found in the wild and natural salmonid populations of the Yakima and Klickitat subbasins. Facility design and operating procedures have modified to accommodate genetic concerns. six of the more important strategies intended to minimize adverse genetic impacts on natural populations are as follows:

1. Identification and separate culture of distinct substocks, which will be outplanted in "ancestral" drainages only.

2. Marking all hatchery juveniles and using only unmarked adults as broodstock.

3. Collecting no more than 10-20 percent of the return of a given stock for broodstock.

4. Implementation of mating schemes that maximize genetic diversity of offspring.

5. Reduction or elimination of hatchery practices that subject fish to artificial selection pressures.

6. Establishing and monitoring unsupplemented control streams, and comparing trends in abundance and inherited characteristics between supplemented and unsupplemented portions of the same stock.

It is important to note that a genetic monitoring and evaluation program will be developed by EDWG to assess the project's central goal of increasing harvest and enhancing long-term productivity without adverse genetic impacts. Planning efforts also include consultation with external experts and coordination/cooperation with the Council's MEG.

3. Harvest Management Plan

Task 4 of the Council's conditional approval of the YKPP requested that a plan be developed for harvest of new production before new construction was initiated. This plan was to include an explanation of how management of the harvest will: 1) provide for the escapement needed to support rebuilding of salmon and steelhead runs in the Klickitat and Yakima subbasins and elsewhere, 2) support the experimentation planned for the project and, 3) affect the management of other fisheries, including effects of mixed-stock harvest on wild and natural stocks. This chapter summarizes the most recent information on harvest management for stocks that will be enhanced under the YKPP. Additional details, including production estimates for a range of supplementation success scenarios, predicted run size, and catch rates for each of the seven stocks are provided in Appendix A.

The harvest management plan was developed jointly by the WDF, the WDW, and the YIN. Information from the Pacific Salmon Commission, the PFMC, members of the Columbia River Compact, and comments of public interest groups were considered in development of the plan.

Harvest management plans are intended to guide the disposition of salmon and steelhead produced within the YKPP facility and in natural habitats. The general framework of the plans balance competing needs for tributary harvest, natural stock escapement, genetic resource conservation, and hatchery broodstock. Relatively conservative terminal harvests are allowed at low stock abundance to accelerate rebuilding while permitting moderate harvest opportunities for treaty and nontreaty fisheries. The harvest plans also reflect a commitment by state and tribal managers to control harvests where necessary to insure that hatchery broodstock requirements are met and to

ensure that natural escapements are sufficiently large to permit evaluation of supplementation experiments.

All Yakima and Klickitat stocks are subject to harvest in ocean and mainstem Columbia River fisheries. However, the specific effects of these preterminal fisheries on YKPP goals and objectives are difficult to assess, Present policy suggests that increases in ocean interceptions above current levels are unlikely. Impacts of in-river fisheries on YKPP fish will depend, in part, on changes in production of other stocks in fisheries that are managed for aggregate-stock escapement goals.

The framework for treaty/nontreaty allocation of spring chinook has been developed, and will likely be used for other stocks of interest (i.e., steelhead). Initially, technical proposals for tributary fisheries are presented to policy representatives of the co-management entities for final negotiation and agreement. Policy-level meetings are then scheduled to arrive at consensus on equitable sharing of harvest opportunities. Upon agreement, the co-managers adopt and exchange regulations for their respective fisheries. Species-specific harvest plans are intended to be implemented as soon as practical for each stock with timing of the harvest plan to be determined jointly by the managers. The managers will also explore and develop methods to forecast stock returns to the terminal areas and develop sampling programs to track the progress of terminal fisheries toward specified harvest goals.

The following sections summarize terminal harvest expectations and pre-terminal fisheries for the eight stocks to be managed under the YKPP. Additional detail is provided in Appendix A.

a. Yakima Spring Chinook

The project master plan stipulates that only 20% of naturally-produced spring chinook adults may be taken for hatchery broodstock as a safeguard to genetic resources. Thus, the broodstock goal of 970 adults will be met at run sizes exceeding the interim escapment goal of 6,000 fish. Conservative harvest rates are fixed on runs up to 12,000 to obtain a range of escapements above the interim goal, which will provide an empirical basis for estimating an MSY escapment goal.

The contribution of Columbia River stocks to all ocean fisheries is thought to be less than 10% of any run. The Columbia River Fish Management Plan (CRFMP) presently limits mainstem harvest impacts on underescaped runs to about 12% of counts at Bonneville Dam. The increased production of Yakima River spring chinook as a result of the YKPP is unlikely to significantly affect mainstem harvest levels. The Yakima River component of the aggregate upriver run of spring chinook is about 10% of the total. Thus, a 70% increase in the Yakima River component would increase the aggregate run by less than 7%. According to estimated MSY harvest rates, runs entering the Yakima River should provide additional terminal harvest opportunities for both treaty and nontreaty fisheries.

b. Yakima Summer Steelhead

The master plan stipulates that treaty and component harvest sharing of steelhead will include harvests in the Columbia River as well as its tributaries. Recreational fisheries in the Yakima River currently are designed to harvest all adipose-clipped steelhead, while reserving wild/natural fish for spawning. An incidental steelhead harvest would occur in tribal subsistence fisheries because fall chinook and coho enter the river with summer steelhead. Under the YKPP master plan supplementation goal, adipose-clipped steelhead will spawn naturally to rebuild the natural stock to MSY levels. Accordingly, harvest rates on adipose-clipped steelhead will be reduced to 55% in all terminal fisheries during the rebuilding phase.

The hatchery broodstock goal of 240 adults (to be taken from naturally-produced adults to preserve genetic stock integrity) will be met at run sizes in excess of 2,525 fish. The interim natural escapement goal of 9,000 adults will be achieved at runs of about 10,250. Terminal harvest rates will be restricted until the interim natural escapement goal is reached. Planned restrictions include release of unclipped fish in the sport fishery and limited tribal harvest at run sizes below interim natural escapement goals.

Columbia River summer steelhead do not contribute significantly to ocean fisheries, but will contribute to treaty commercial and nontreaty recreational fisheries in the mainstem Columbia River. The relative abundance of Yakima

stocks are considered in the CRFMP so tributary fishing opportunities "are not precluded." Harvest rates on Yakima River steelhead in mainstem fisheries have been about 15% for unclipped fish and 20% for adipose-clipped fish. According to estimated MSY harvest rates, runs entering the Yakima River should provide additional terminal harvest opportunities for both treaty and nontreaty fisheries.

c. Yakima Fall Chinook

The broodstock goal of 1,070 will be met at natural escapements greater than 1,780 from runs exceeding 2,250 fish. The interim natural escapement goal of 10,000 adults will be achieved with runs of 13,800. Terminal harvest rates for all fisheries are 20% on runs less than 13,800, and will be determined by agreement of the co-managers at run sizes larger than 13,800.

The contribution of Yakima River fall chinook to ocean fisheries is high. They also contribute to treaty and nontreaty fisheries in the Columbia River. Harvest rates of 20 to 25% may be expected in nontreaty fisheries below Bonneville Dam. Treaty fisheries above Bonneville Dam may harvest up to 45% under agreements established in the CRFM Plan. Benefits of increased production of fall chinook salmon in the Yakima River will be distributed among all users. In order to meet harvest and other needs, the YKPP must succeed in enhancing both stock status and productivity,

d. Yakima Summer Chinook

A harvest management plan will be developed for terminal fisheries as production plans for this stock become more certain. Stocks of Columbia River summer chinook are subjected to rebuilding efforts through harvest protection and enhancement. Only small numbers of summer chinook are harvested in tribal fisheries. The CRFMP specifies that incidental harvest impacts are not to exceed 5% of in-river run size in any treaty or nontreaty fishery. Summer chinook are generally protected in ocean fisheries by weak stock management guidelines and it is unlikely that ocean harvest rates will increase.

e. Yakima Coho

The harvest plan for Yakima coho emphasizes terminal harvest of all coho in excess of hatchery needs. The broodstock collection goal of 2,350 adults

will be met regardless of tributary run size by importing surplus coho from other hatcheries if both harvest and broodstock needs are not met. Terminal fisheries will be managed for 50% harvest rates on runs less than 4,700 and for all harvestable surplus on runs exceeding that number.

Yakima coho are caught extensively in sport and commercial ocean fisheries, but tend to escape the higher in-river harvest rates experienced by later-migrating stocks. It is conceivable that 75 to 90% of the coho run will be harvested in ocean and in-river fisheries before it enters the Yakima River. Thus, it is unlikely that natural production of coho in the Yakima subbasin can be sustained. However, harvest opportunities will occur in the Yakima River if the supplementation program meets expectations.

f. Yakima Sockeye

No harvest plans have been developed for this species pending feasibility studies.

g. Klickitat Spring Chinook

Spring chinook are currently being produced at the WDF's Klickitat Hatchery and future production plans will be integrated with those of the YKPP. The hatchery broodstock goal of 2,900 adults will be met at run sizes of about 4,150 fish. The interim natural escapement goal of 4,000 adults will be achieved with runs exceeding 9,800. Harvest rates for all terminal fisheries will not exceed 30% on runs less than 9,800 chinook and will be determined by agreement of the parties at larger run sizes. This harvest rate reflects the need to provide harvest opportunities to high-priority tribal and recreational spring chinook fisheries on the Klickitat River.

The contribution of Klickitat spring chinook to ocean fisheries is thought to be less than 10% of the run. Current harvest management plans suggest that significant changes will not occur. The CRFMP anticipates increased mainstem harvest of spring chinook as upriver stocks rebuild. However, because the plan limits harvest impacts on underescaped runs to about 12% of counts at Bonneville Dam, increased production of Klickitat spring chinook as a result of the YKPP is unlikely to significantly affect mainstem harvest levels. According to estimated MSY harvest rates, runs entering the

Klickitat River should provide additional terminal harvest opportunities for both treaty and nontreaty fisheries.

h. Klickitat Summer Steelhead

The CRFMP stipulates that treaty and nontreaty harvest sharing of steelhead will include harvests in the Columbia River as well as in its tributaries. Recreational steelhead fisheries are designed to harvest adipose-clipped hatchery steelhead while reserving wild/natural fish for spawning. An incidental steelhead harvest will occur in tribal fisheries on fall chinook and coho. Under YKPP supplementation goals, adipose-clipped steelhead will spawn naturally to rebuild the natural stock to MSY levels. Accordingly, harvest rates on adipose-clipped steelhead will not exceed 55% in all terminal fisheries during the rebuilding phase. The hatchery broodstock goal of 350 adults will be met at natural escapements of 3,500 adults from runs of about 4,100 fish. The interim natural escapement goal of 5,000 adults will be achieved at runs of about 6,250. Terminal harvest rates will be restricted until the interim natural escapement goal is reached. The tribal harvest will be limited to 5% and 15% of the wild/natural runs at levels of less than 3,000 and 3,000-6,000, respectively.

Columbia River summer steelhead do not contribute significantly to ocean fisheries. However, Klickitat steelhead will contribute to treaty commercial and nontreaty recreational fisheries in the mainstem Columbia River. The relative abundance of Klickitat stocks are considered in the CRFMP so tributary fishing opportunities "are not precluded." Harvest rates on Klickitat steelhead in mainstem fisheries are probably less than 10% for unclipped fish and 15% for adipose-clipped fish. According to estimated MSY harvest rates, runs entering the Klickitat River should provide additional terminal harvest opportunities for both treaty and nontreaty fisheries.

4. Refined Adult Production Goals

The following sections summarize the current production goals for each of the eight stocks managed within the YKPP (YIN et al. 1990). Standardized measures of increases in run size and harvest expected from the YKPP have been computed for each stock using the approach employed in subbasin planning. These numbers are reported in Appendix A (Refined Goals and Harvest Management

Plan) under various YKPP scenarios and summarized in Table 1. They indicated that improved in-subbasin smolt survival enhances the effectiveness of the YKPP more than any other measure. The refined production goals for the Yakima subbasin are well defined for most species. Goals for the Klickitat subbasin are'more preliminary, but are expected to be equally well defined by 1992.

a. Yakima Spring Chinook

Maximum survival rates of spring chinook hatchery smolts have been about 20% of observed natural survival. However, investments in the experimental program are expected to increase this relative survival (henceforth referred to as "supplementation success") to about 60%. The goal for spring chinook is to increase the adult production potential by about 65 to 70% above the current level. When these goals are met the sustainable harvest is expected to double. These production goals are achievable from a hatchery production level of 1.6 million spring chinook smolts if a 61% supplementation success is realized.

b. Yakima Summer Steelhead

The maximum expected supplementation success for steelhead was set at the 60% figure ascribed to spring chinook. The goal for summer steelhead is to increase the adult production potential in the Yakima River by about 65 to 70% from the present level, which would result in about a fourfold increase in sustainable harvest. These production goals are achievable from a hatchery production level of 400,000 steelhead smolts. Scenarios for the Satus Creek substock and potential use of habitat above Roza Dam were also considered in analyses.

c. Yakima Fall Chinook

Minimum expected supplementation success for fall chinook is 60%. This value is higher than those applied to other species because of the shorter freshwater rearing time and because they can be expected to undergo proportionately less maladaptive artificial selection. The goal is for fall chinook to increase the adult production potential by about 90 to 95% from the current level, which would result in about a fourfold increase in sustainable harvest. These production goals are achievable from a hatchery production

TABLE 1. Production Summary Table

Species/Race	Return to Yakima, Current 5-yr Mean	Total Run Size[a] Pre-YKPP Production Potential(b)	Post-YKPP Production Potential(c)	Post-YKPP Production Potential With Improved In-Subbasin Smolt Survival[d]
YAKIMA RIVER				
Spring Chinook	5,647	9,801	16,466	41,458
Summer Chinook	0	[5,488[e]]	5,982	20,745
Fall Chinook	1,959	18,450	35,666	44,352
Coho	0	[0[f]]	14,545	24,933
Steelhead	2,154	7,199	11,950	49,385[g]
Sockeye	0	[0[h]]	Unknown(')	Unknown[i]
KLICKITAT RIVER				
Spring Chinook	2,523[j]	3,000	20,000	20,000[k]
Steelhead	2,034[l]	6,000	12.004	12,000[k]
TOTALS	14,317	44,450	116,609	212,873

(a) Ocean harvest plus run size at the mouth of the Columbia River. Note that the ocean harvest is assumed zero for steelhead.
(b) Production potential as estimated in Yakima and Klickitat Subbasin Plans (see Refined Goals).
(c) Production potential as estimated in the Yakima and Klickitat Subbasin Plans (see Refined Goals).
(d) Includes all measures in the Yakima Subbasin Plan intended to improve in-subbasin smolt survival: halving losses in the open river (possibly with a squawfish control program), rebuilding Phase-II screens and subordinating power generation (to instream flow) and rebuilding the bypass system at Wapato diversion on the Naches River.
(e) Without hatchery it is unlikely that current potential can be realized.
(f) Current oceanic and estuarine harvest rates preclude natural coho production in the Yakima River.
(g) Includes'habitat above Roza Dam.
(h) Existing data insufficient to model sockeye production.
(i) No quantitative objectives have been set for sockeye due to lack of data.
(j) Six-year mean based on available data from 1978, 1980-1983, and 1985.
(k) In the absence of data to the contrary, survival of natural smolts in the Klickitat River is assumed to be nearly optimal already.
(l) Six-year mean based on data from 1981-1982. Note that run size was estimated on the basis of total catch and an assumed ratio between catch and run size.

level of 3.6 million smolts at 100% supplementation success. The MSY terminal harvest can be substantially increased by increasing terminal harvest rates and by improving the survival of outmigrating smolts in the subbasin.

d. Yakima

The principal purpose of the summer chinook program is to reintroduce the stock in the subbasin. AT MSY, the potential total run (escapement to the Columbia River plus prior ocean harvest) and escapement to the Yakima River of a re-established unsupplemented summer chinook population is 5,488 and 2,898, respectively. The production objective is currently limited to 156,000 smolts, but total production would be increased significantly at greater numbers.

e. Yakima

Coho will be harvested at a rate that will maximize harvest of hatchery fish. Estimated benefits of the YKPP on coho must be displayed differently from the other Yakima River species because there is no baseline population for comparison. From a release of 2 million smolts, the simulation predicted a total run (escapement to the Columbia River plus prior ocean harvest) of 14,545 fish. This included an escapement to the Yakima River of 3,779 fish (including 6 natural), a terminal harvest of 907, and a total harvest to all fisheries of 9,614. Predictions of the benefits of supplementation for coho are imprecise because it is not presently possible to judge whether smolt-to-adult returns rates will be closer to 0.7% or 2.0%.

f. Yakima Sockeye

No sockeye production is included in the YKPP pending outcome of ongoing feasibility studies. Analysis of potential benefits from supplementation is currently under consideration.

g. Klickitat Summer Steelhead

Klickitat steelhead production will be phased in over 10 years from an estimated 6,000 to 12,000 fish. The preliminary assessment of the numbers of smolts required to meet this goal is 260,000. Remaining uncertainties about supplementation opportunities in the Klickitat subbasin will be removed once a better understanding is attained of potential access to spawning and rearing

areas above Castile Falls. The hatchery brood stock goal of 350 adults will be met a natural escapements of 3,500 adults from runs of about 4,100 fish.

h. Klickitat Spring Chinook

The adult production goal is to increase the MSY run size from about 3,000 to 20,000 over the baseline by year 10. The preliminary assessment of smolt production to achieve this goal is 3 million. Remaining uncertainties about supplementation opportunities in the Klickitat subbasin will be removed once a better understanding is attained of potential access to spawning and rearing areas above Castile Falls, and after more detailed information is obtained about potential release sites. The combined hatchery broodstock goal of 2,900 adults will be met at run sizes of about 4,150 fish.

B. EXPERIMENTAL DESIGN PLAN

1. Process for Development, Implementation, and Coordination

This section summarizes the current status of the experimental design plan for supplementation of salmonid populations in the Yakima and Klickitat subbasins under the YKPP. The central hypothesis is that new artificial production in the Yakima and Klickitat subbasins can be 'used to increase harvest and to enhance natural production without adversely affecting genetic resources. The YKPP will help to determine what role supplementation should have in rebuilding production in the Columbia Basin. The first annual report on YKPP experimental features (EDWG 1988) recognized a necessary evolution in the development of the final pre-implementation design for experimentation, monitoring and evaluation. The most recent report (Experimental Design Plan, Annual Report 1990, Appendix A) identifies unanswered questions related to the physical and biological resources of the Yakima and Klickitat subbasins that constrain the experimental design task. Experimental hypotheses relating to critical uncertainties are outlined for both pre-facility and post-facility phases. The report also describes an approach that recognizes predesign uncertainties and hatchery design/implementation needs.

An annual, integrated course of pre-facility planning will continue through 1995 for the Yakima system, when hatchery production and experimentation are expected to begin. A similar schedule is planned for the

Klickitat system with implementation expected in 1997. Implicit communication links contained in the planning cycle enhance coordination and guide success of the YKPP EDWG plans. These include regular meetings, external peer-review of products, and dual membership roles on related TWGs. Although implementation of the experimental plan is envisioned in 5-year cycles, review and modifications, based on progress of experimental results, will occur on an annual basis. A process intended to assure full and timely consideration of experimental results at both policy and technical levels of project management is in place. As a part of this process, the EDWG will continue to provide technical oversight for experimental plan development, review, modification, and reporting of results.

The YKPP recognizes that coordination with other project in the Columbia Basin is vitally important. At the present time, coordination is occurring by means of EDWG members who participate with other TWGs throughout the Columbia Basin. It is anticipated that coordination will continue at this level and through other evolving mechanisms.

2. Experimental Program

A basic goal of the YKPP is to enhance stocks of salmon and steelhead through hatchery supplementation, without creating separate hatchery and natural populations with irreconcilable harvest and escapement needs. Stocks planned for the YKPP include spring, fall, and summer chinook salmon, coho salmon, sockeye salmon, and steelhead trout in the Yakima subbasin; and spring chinook salmon and steelhead trout in the Klickitat subbasin. Each of the eight stocks has differing supplementation objectives that are described in more detail in this document.

The success of supplementation is founded on a set of operating assumptions that are reasonable in the light of what is currently known. These assumptions are:

- that hatchery-reared fish will survive and return to the target spawning areas at rates equal to substantial fractions (60% or more) of estimated natural rates
- that supplemented populations will successfully reproduce
- that supplemented populations will remain fit over the long term

- that supplementation will not occasion inter- and intra-specific interactions that cannot be managed to avoid unintended effects.

Hatchery practices must be carefully standardized in order to avoid experimental confounds. Therefore, rigid guidelines for hatchery operations will be developed and observed. It should be clearly noted that hatchery practices are not treated as an experimental variable.

The experimental criteria are designed to provide a reliable resolution of the central hypothesis of the YKPP program within as short a time frame as possible. Accordingly, scientifically sound experiments will be designed and conducted. These experiments will account for such statistical considerations as power, significance, and bias. Applicability of results and conclusions elsewhere in the Columbia Basin is a vital element of all experimental designs.

The experimental design is an iterative process using knowledge gained at each step to refine future actions. Available information from the literature and ongoing studies in the Yakima subbasin are used to develop the initial program. Pre-facility studies described in annually-revised working plans will provide information for future iterations. The third stage of refinement will occur after hatchery-reared fish become available to conduct the first set of structured hypotheses testing. Each iteration of the experimental design program will consist of a three-step sequence of activities, beginning with the identification of critical uncertainties, proceeding to the definition of appropriate response variables, and concluding with the modification of previous uncertainties and hypotheses in the light of new experimental data.

The central experimental hypothesis of the YKPP will be evaluated against criteria in four primary population response categories: 1) post-release survival of hatchery fish, 2) reproductive success of supplemented populations, 3) long-term fitness of supplemented populations, and 4) inter- and intra-specific interactions. Quantifying the response of populations in these areas is a complicated task, which will entail the monitoring and evaluation of a wide array of biotic and abiotic factors.

Post-release survival is defined as the survival rate from newly-released smolt to returning adult. It is important that post-release survival be high enough that the advantages attributable to artificial incubation and rearing are not offset. The in-subbasin survival of outmigrating smolts is an important component of post-release survival. In-subbasin survival has been identified as a critical uncertainty for both supplemented and natural smolts, and is being investigated by pre-facility studies. It should be borne in mind that the standard against which post-release survival will be assessed is the survival of natural fish.

Reproductive success is defined as the number of offspring produced per unit of spawners. The relative reproductive success of hatchery, mixed ("hybrid"), and natural matings is a critical uncertainty.

In the context of the YKPP, a "fit" population is one that maintains its genetic identity and diversity. The maintenance of fitness of supplemented populations over the long term is a critical uncertainty. In order for fitness to be maintained, existing substocks must be identified, and appropriate broodstock collection practices must be developed and implemented.

Species interactions consist of the effects supplemented populations have on a species of interest. Measurable components of species interactions include population abundance and distribution, growth rate, carrying capacity, and survival rate. In particular, interaction between supplemented populations of steelhead trout and resident rainbow trout has been identified as critical uncertainty.

Supplementation objectives, critical uncertainties, and pre-facility needs have been developed for each of the stocks to be supplemented under the YKPP (Table 2). Initial experimental hypotheses and experimental protocols have also been identified. Current detail on hypotheses relating to critical uncertainties reflect "state-of-progress" for issues dealt with to date. Annual review will result in elaboration and refinement of the experimental plan.

3. Monitoring Program

A monitoring program is being developed to measure responses of salmonids in the Yakima and Klickitat subbasins to supplementation activities.

TABLE 2. Current Status of Experimental Planning for Stock-Specific Features of the Program

Yakima Basin Spring Chinook Salmon

Supplementation Goal

Increase production potential to 65% above current level.

Critical Uncertainties

- In-river survival rates for smolts, where mortality occurs, and factors causing mortality.
  Strategies for acclimation that optimize survival
  Reproductive success of adult returns from hatchery stocks and naturally-produced fish.
  Number and distribution of genetically distinct substocks in the basin.

Pre-facility Needs

Test the effect of different release treatments (i.e. acclimation, conditioning) on survival of smolts.
- Determine homing ability and distribution of returning supplementation adults.
- Develop methods for monitoring the reproductive success and long-term fitness of hatchery supplementation fish.
  Determine any adverse genetic effects occurring in both supplementation and naturally-produced fish.

Yakima Basin Summer Steelhead

Supplementation Goal

Increase adult production potential in the Yakima River to 65% above current level, while maintaining Satus Creek production at current levels.

Critical Uncertainties

Effects on genetic variability of rearing all supplementation steelhead for one year.
In-river survival rates for smolts, where mortality occurs, and factors causing mortality.
Most efficient size and time of release for outplanting steelhead.
The genetic effect of using hatchery-reared native stock to supplement natural production.
Effects of re-introduction of steelhead stocks into areas with no current production.

Pre-facility Needs

- Determine locations and cause of in-basin smolt mortality.
- Develop and calibrate smolt and adult monitoring capabilities.
  Test the effect of different release treatments (i.e. acclimation, conditioning) on survival of smolts.
  Develop methods for monitoring the homing ability and reproductive success of hatchery supplementation fish.
  Evaluate the effect of steelhead supplementation on populations of resident trout.

TABLE 2. (contd)

Yakima Basin Fall Chinook Salmon

Supplementation Goal

Increase production to 95% above the current level.

Critical Uncertainties

Effects of different strategies for rearing, acclimation, and release on post-release survival.
Effects of rearing/release site and acclimation time on age-at-return, maturation, and distribution of spawners.

Pre-facility Needs

Determine levels, sources, and seasonal/annual variability of smolt mortality during emigration.
Develop culture strategies to maximize post-release survival of fall chinook smolts.
Develop smolt monitoring capabilities near the mouth of the Yakima River.
Develop adult monitoring methodologies to estimate proportions of hatchery returns in lower river spawning areas.
Develop methods to estimate adult escapement and smolt outmigration.
Assess the sensitivity of reproductive success to changes in female reproductive potential needs.
Define genetic and biological characteristics of existing populations.
Develop genetic monitoring and evaluation plans for facility implementation.

Yakima Basin Summer Chinook Salmon

Supplementation Goal

Successfully reintroduce the stock into the basin.

Critical Uncertainties

Effects of hatchery rearing and release strategies on smolt-to-adult survival.
Effects of adverse temperature, stream flow, and water quality conditions during summer juvenile rearing/emigration, and adult entry.

Pre-facility Needs

Assess the genetic risk of interbreeding with natural spring chinook stocks and recommend hatchery production alternatives to avoid it.

Yakima Basin Coho Salmon

Supplementation Goal

Create an additional fall harvest opportunity maximizing harvest of hatchery fish.

Critical Uncertainties

- Factors affecting smolt-to-smolt survival.

Pre-Facility Needs

Determine levels, sources, and variability of smolt-to-smolt mortality.

(Continued 2.

Yakima Basin Sockeye Salmon

Supplementation Goal

No objectives have been developed, pending results of a feasibility study conducted in Lake Cle Elum.

Critical Uncertainties

- Further experimental design planning has been delayed pending development of a supplementation objective.

Klickitat Basin Summer Steelhead

Supplementation Goal

Achieve a total adult run size of about 12,000 by year 10 of the program.

Critical Uncertainties

Potential for establishing adult passage over Castile Falls
Monitoring capabilities measuring post-release survival.
Availability of acclimation sites.
- Maintenance of fitness or maximizing long-term production potential.
Potential for interaction between hatchery-produced summer steelhead and both naturally-produced summer and winter steelhead stocks.

Pre-facility Needs

Assess acclimation options.
Compare genetic and biological characteristics of current natural and hatchery populations of steelhead (including winter run).
Identify and test monitoring options which will meet experimental requirements of the program.
Reassess current production and evaluation strategies for consistency with stated objectives.

Klickitat Basin Spring Chinook Salmon

Supplementation Goal

Achieve a total adult run size of 20,000 by year 10 of the program.

Critical Uncertainties

- Measurement capabilities for estimating post-release survival.
- Availability of acclimation sites.
- Operation of current hatchery programs in the Klickitat basin.
Maintenance of fitness or maximizing long-term production potential.

Pre-facility Needs

Assess acclimation options.
Compare genetic and biological characteristics of current natural and hatchery populations of steelhead (including winter-run).
Identify and test monitoring options which will meet experimental requirements of the program.
Reassess current production and evaluation strategies for consistency with stated objectives.

Population responses are measured in terms of survival by life stage (post-release survival), reproductive success, long-term fitness (genetics monitoring), and interactions effects. Specific response variables that must be measured include: 1) survival of fish from release through outmigration, 2) contribution to major fisheries, 3) adult returns to the subbasin, and 4) spawning. Additional response variables measuring reproductive success and long term fitness are being identified. Development of appropriate methods for monitoring these characteristics is a primary goal of the pre-facility experimental program. Response variables for studies of genetic effects of supplementation, intra-specific and inter-specific interactions, and stock assessment must be identified and coordinated within the monitoring program. Sampling rates, locations, schedules, and procedures will be further refined as current baseline data collection studies provide more information and as research needs are further refined.

C. SALMONID HEALTH STRATEGIES

Construction and operation of efficient fish hatchery and supplementation programs for the YKPP will be contingent upon an understanding of the fish health status of donor and target stocks, as well as a thorough knowledge of pathogenic organisms within the watersheds. The successful reintroduction of salmonid species (e.g., sockeye, summer chinook, and coho salmon) into the Yakima River subbasin will also require an ongoing profile of fish health status. Recently, the Pacific Northwest Fish Health Protection Committee (PNFHPC) formulated and adopted a comprehensive fish health protection plan (PNFHPC 1988). The plan is a dynamic compendium of policies and practices for fish health protection, and will guide the design and operation of facilities within the YKPP.

Currently, the incidence of infectious fish diseases in the Yakima subbasin is largely unknown. However, ongoing investigations of potential salmonid parasites and pathogens, as well as historical records of propagation facilities within the Yakima and Klickitat subbasins, suggest fish health problems may be similar to those at similar facilities in the Pacific Northwest. In 1989, the NMFS, U.S. Fish and Wildlife Service, and the YIN began investigations to determine the incidence and geographic distribution of

significant salmonid parasites and pathogens that could affect the proposed supplementation/enhancement project.

Though sampling is only preliminary, the presence of several pathogens has been detected at low rates of incidence within the Yakima and Klickitat watersheds. For example, the salmonid virus responsible for infectious hemopoietic necrosis (IHN), and two parasites, Nanophyetus salmonicola and Sphaerophorg sp., were recently isolated from fall chinook in the lower Yakima River. Only 8 of 106 (7 %) adult samples collected in 1989 were IHN positive, In addition, the bacterium which causes bacterial kidney disease (BKD) was present in 5% of the same samples of fall chinook.

It should be noted that IHN has not been detected in any of the 191 wild/natural spring chinook sampled to date (191 adult fish were collected at Roza Dam in 1984 and 1985 as broodstock for experimental smolt releases in the upper Yakima. All fish were tested for IHN at the time of spawning), Nor has IHN been detected in wild/natural summer steelhead: none of the more than 500 fish collected as broodstock over the past three years was IHN positive.

The tribe and cooperating state and federal management agencies will utilize the latest and best available husbandry and disease prevention techniques to minimize morbidity and mortality from fish diseases. For example, studies are currently underway to evaluate an enzyme-linked immunoabsorbant assay (ELISA) based segregation method for control of BKD. Preliminary results suggest that this technology may be successfully applied within the YKPP. There are also other ongoing or planned research projects with potential to provide insight into the control of BKD, IHN, Saprolegniasis, Ceratomyxosis, Erythrocytic Inclusion Body Syndrome, and/or other infectious diseases and parasites of salmonids.

The following seven operational plans are designed to reduce the impact of infectious diseases and will be implemented at the onset of fish culture:

1. Chinook and coho broodstock will be injected with erythromycin to reduce pre-spawning mortality due to BKD, and to decrease the incidence and severity of this disease in offspring.

2. Eggs from one to five females will be incubated separately to allow for quarantine, or in some cases destruction, if testing reveals the presence of vertically transmissible diseases of concern.

3. Separate incoming water supplies from the same or similar sources will be used where possible during holding periods for both discrete stocks and for different year-classes of fish. Re-use water will not be used in any of the facilities.

4. Fish husbandry and health practices recommended by the PNFHPC will be followed.

5. Coordination will be maintained with the WDF and WDW to ensure that all fish and gametes brought into the Yakima and Klickitat subbasins and/or released from central outplanting facilities, are certified as meeting state standards to reduce the incidence and spread of disease as specified in Washington Administrative Code, Chapter 220-77.

6. A YKPP fish pathologist will work full time on fish health protection measures.

7, A state-of-the-art fish pathology lab will be built at Oak Flats, and satellite wet labs will be built at all other rearing sites.

D. PRELIMINARY ENGINEERING WORK PLAN

Preliminary engineering studies were conducted to provide plans for construction of salmon and steelhead facilities in the Yakima and Klickitat subbasins (Appendix C). The funding and authorization for the preliminary design reports were provided by BPA under provisions of the Council's Columbia River Basin Fish and Wildlife Program. These reports will serve as a guide to be used by TWGs and design engineers to implement final project design and construction.

The purpose of the predesign phase was to finalize the nature and location of various fish-production facilities consistent with the Yakima and Klickitat Rivers Central Outplanting Facility Master Plan (FMC 1987) and the Report on Refined Project Goals and Management Plan for the Yakima/Klickitat Production Project (February 1989, Appendix A). Participants in planning included BPA, YIN, WDW, WDF, USBR, experts in fish hatchery design/culture, and consulting engineers. Specific production goals and other requirements were developed with input from the EDWG.

1. Yakima Salmon and Steelhead Facilities

The goal of the Yakima subbasin production program is to produce high quality smolts that meet the objective of supplementation within the

guidelines of the experimental design. The production goals (Table 3) are consistent with the Master Plan and reflect the most recent requirements for production and experimental design. EDWG is preparing a separate report that will explain the rate at which the program will develop to meet these goals.

BPA prepared a Draft Environmental Assessment (EA) in 1989 explaining all of the facilities and alternative sites considered in the Yakima subbasin. Sites finally selected for use in the Yakima subbasin program are listed in Table 4 and their corresponding locations are shown in Figure 3. At this

TABLE 3. Yakima River Basin Production Goals

Species	Number	Size	lb Production	Number of Experimental Groups
Upper Yakima Spring Chinook	1,150,000	15/lb	76,667	15
Naches Spring Chinook	450,000	15/lb	30,000	6
Naches Summer Chinook	200,000	15/lb	13,333	N/A
Naches Summer Steelhead	400,000	7/lb	57,143	12
Fall Chinook	3,600,000	65/lb	55,385	18
Lower Yakima Coho	1,550,000	15/lb	103,333	3
Naches Coho	450,000	15/lb	30,000	6
TOTAL	7,800,000		365,861	

TABLE 4. Yakima Basin Fish Facilities

Central Hatcheries

Oak Flats
Cle Elum
Nelson Springs

Satellite Facilities

Wapato
Prosser

Acclimation Sites

Summer Steelhead (12)
Upper Yakima Spring Chinook (15)
Naches Spring Chinook (6)

Adult Trapping Sites

Roza Dam
Cowiche Diversion
Prosser Dam

Juvenile Trapping Sites

Roza Dam
Oak Flats
Chandler Canal

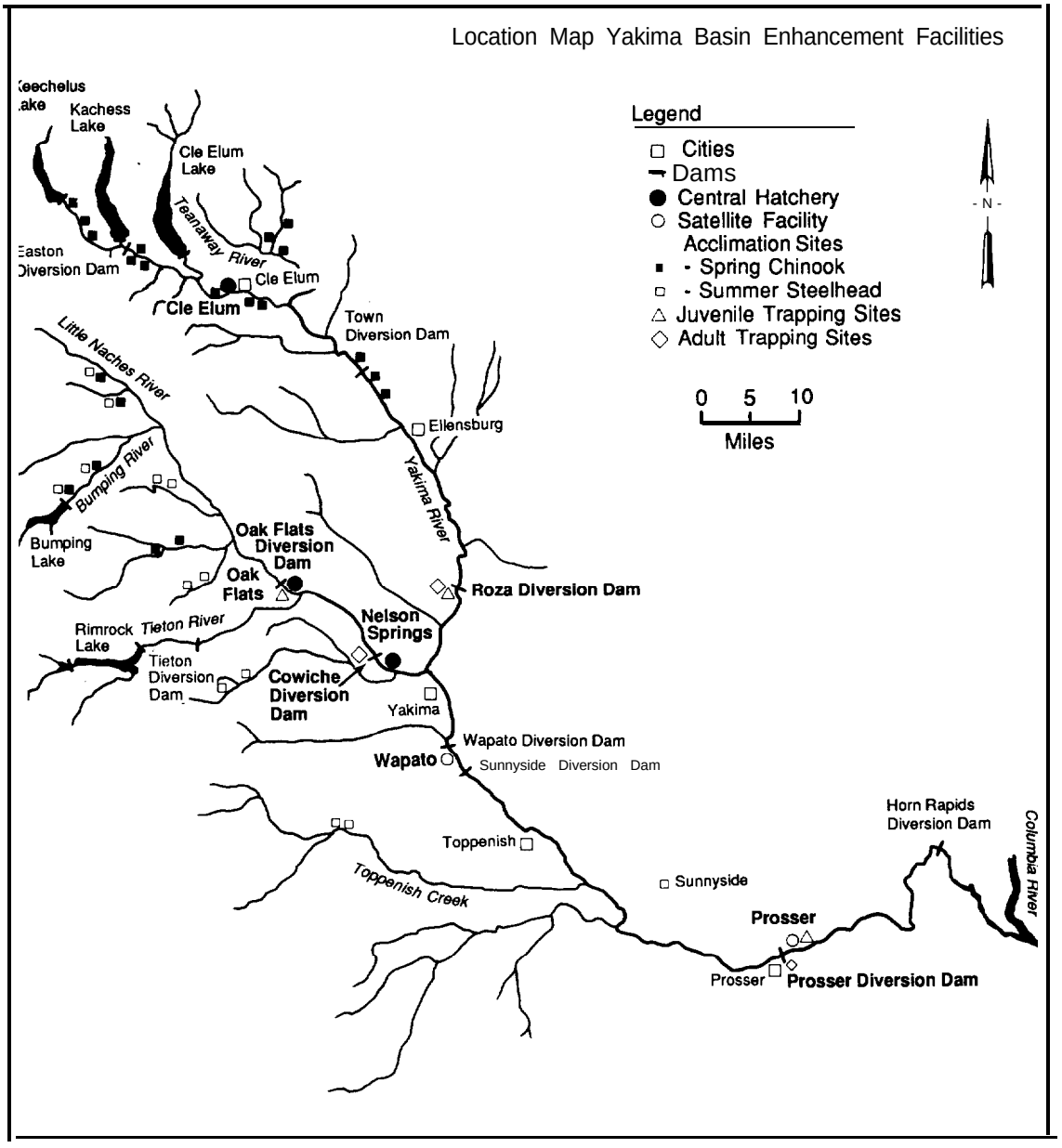


FIGURE 3. Map of the Yakima Subbasin and Location of Facilities

time, specific locations of the acclimation sites have not yet been finally determined. However, the locations shown on Figure 3 represent EDWG's most recent plan for acclimation and release in respective stream reaches.

The most important criteria for the fish culture program are water quality and quantity. The water analysis report (Appendix B) containsdetailed

information on the water quality and water quantity present at each of these sites. General water quality guidelines for fish culture facilities were taken from standards developed by the Alaska Department of Fish and Game. Additional criteria related to disease control have been agreed upon in the hatchery design and include methods for incubation, rearing and adult holding. If the desired water temperature cannot be obtained from existing sources, water chilling may be required. Desired flow rates for each of the fish culture facilities were estimated from calculation of flow and space requirements by species (Appendix C). These flow rates will be compared with the actual flow rates available (as documented in the Water Analysis Report, Appendix B) to assess potential constraints on fish production.

The biological programming of each fish species through each facility was accomplished using a computer program developed by Fish Management Consultants. This program yields space, flow, and food requirements for each targeted stock (Figures 4 through 13). Programming was based on a discrete number of experimental groups within each stock of fish. Fish production schedules and the requirements for rearing and incubation of experimental groups have been coordinated and carefully reviewed. Criteria were developed for the freshwater portion of the life cycle of targeted stocks and include provisions for adult holding and spawning, incubation of eggs and alevins, rearing, food consumption, transportation of fish, and manpower. Additional details on these criteria are provided in Appendix C.

Details on facility design include a general site description, including location of alternative sites, facility size, production goals review, and current land use and ownership (Appendix C). Discussions of site development include construction constraints and power sources. Water sources and water treatment methods are detailed for each site being considered for development. The number and types of buildings and equipment required for operation are also provided.

The Cle Elum site was chosen as the central hatchery facility for upper Yakima spring chinook. In addition, Naches spring chinook eggs will be moved from Oak Flats to this site after they reach the eyed stage, and will be incubated and reared here until being returned to Oak Flats as fingerlings.

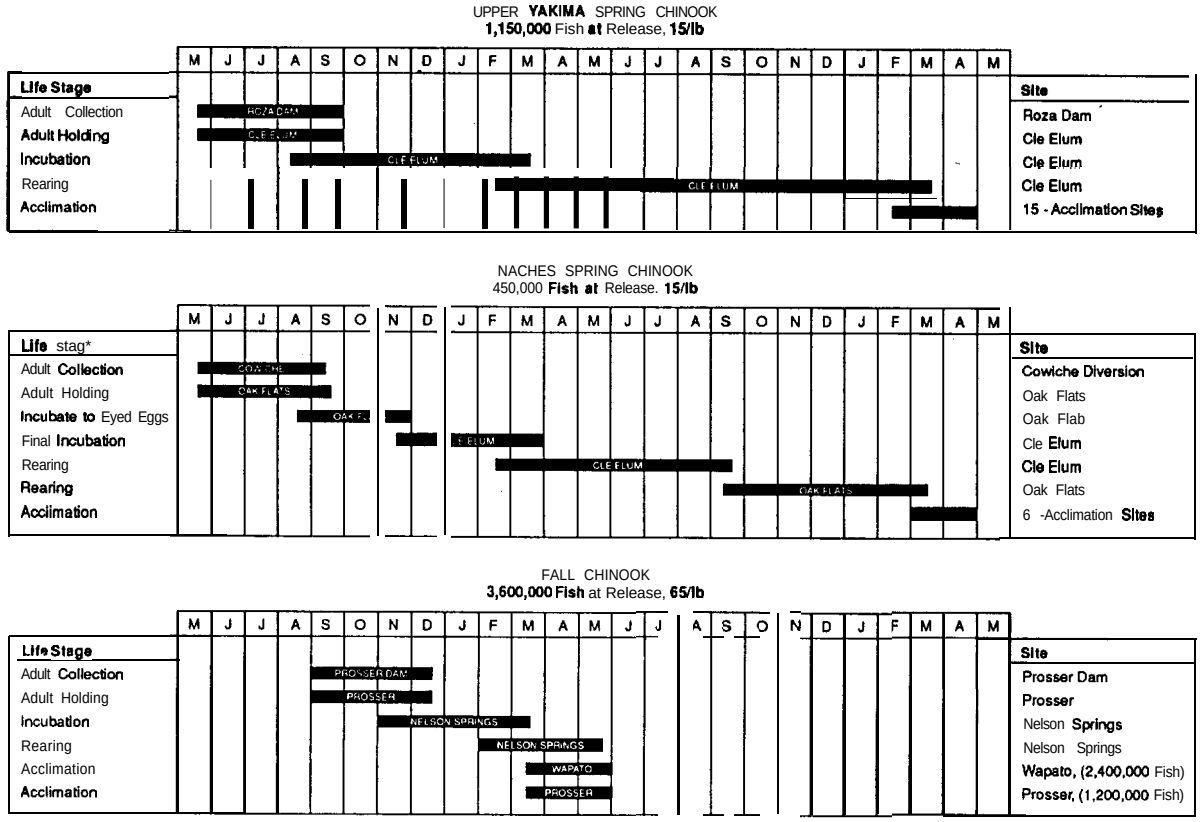


FIGURE 4. Yakima Subbasin Fish Culture Schedule by Species

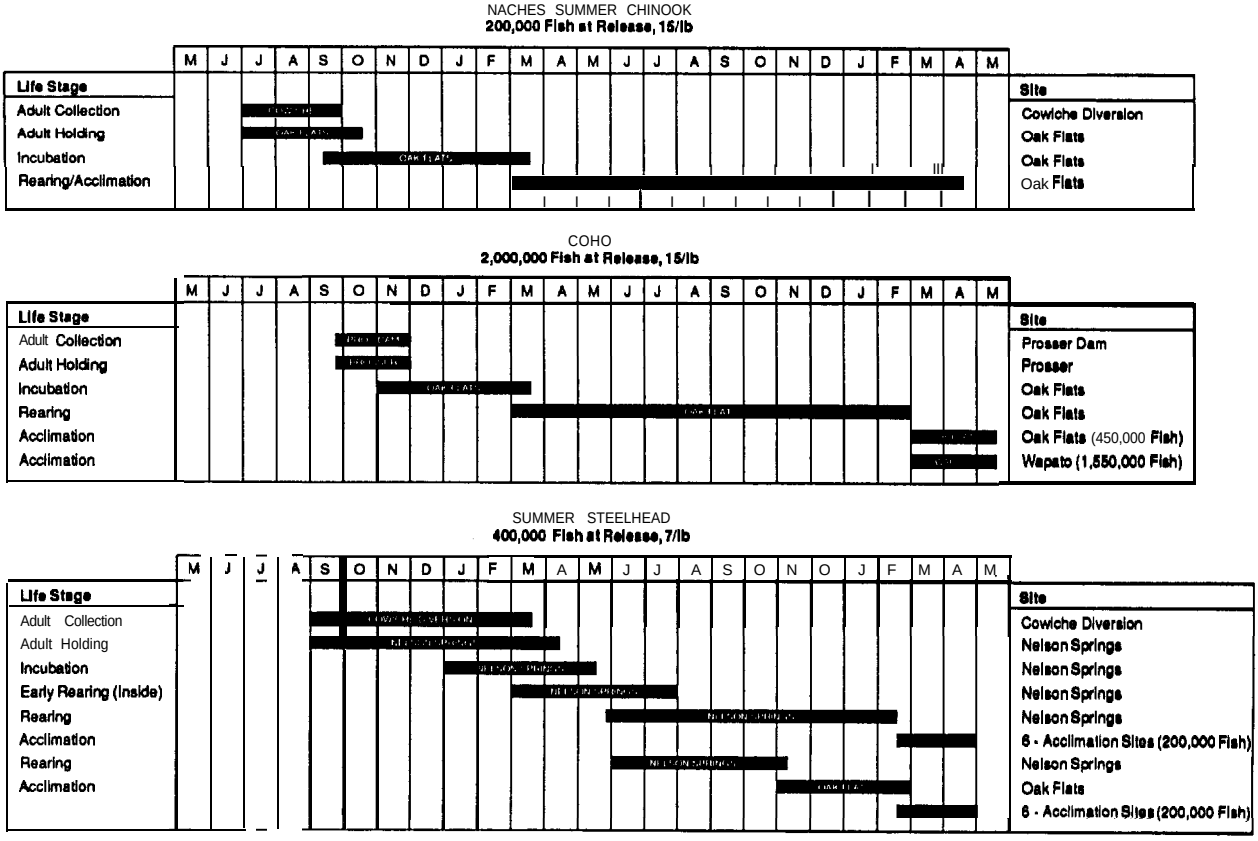


FIGURE 4. (contd)

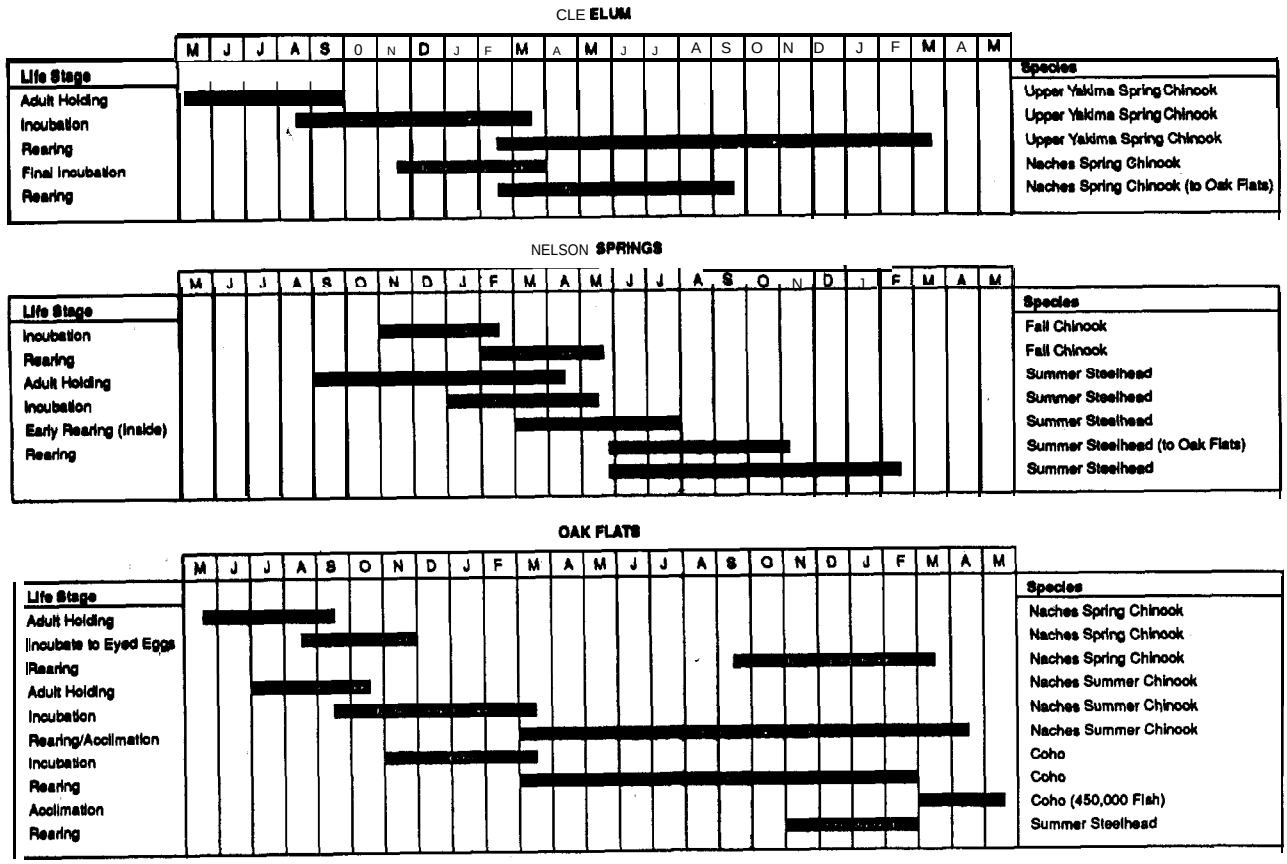
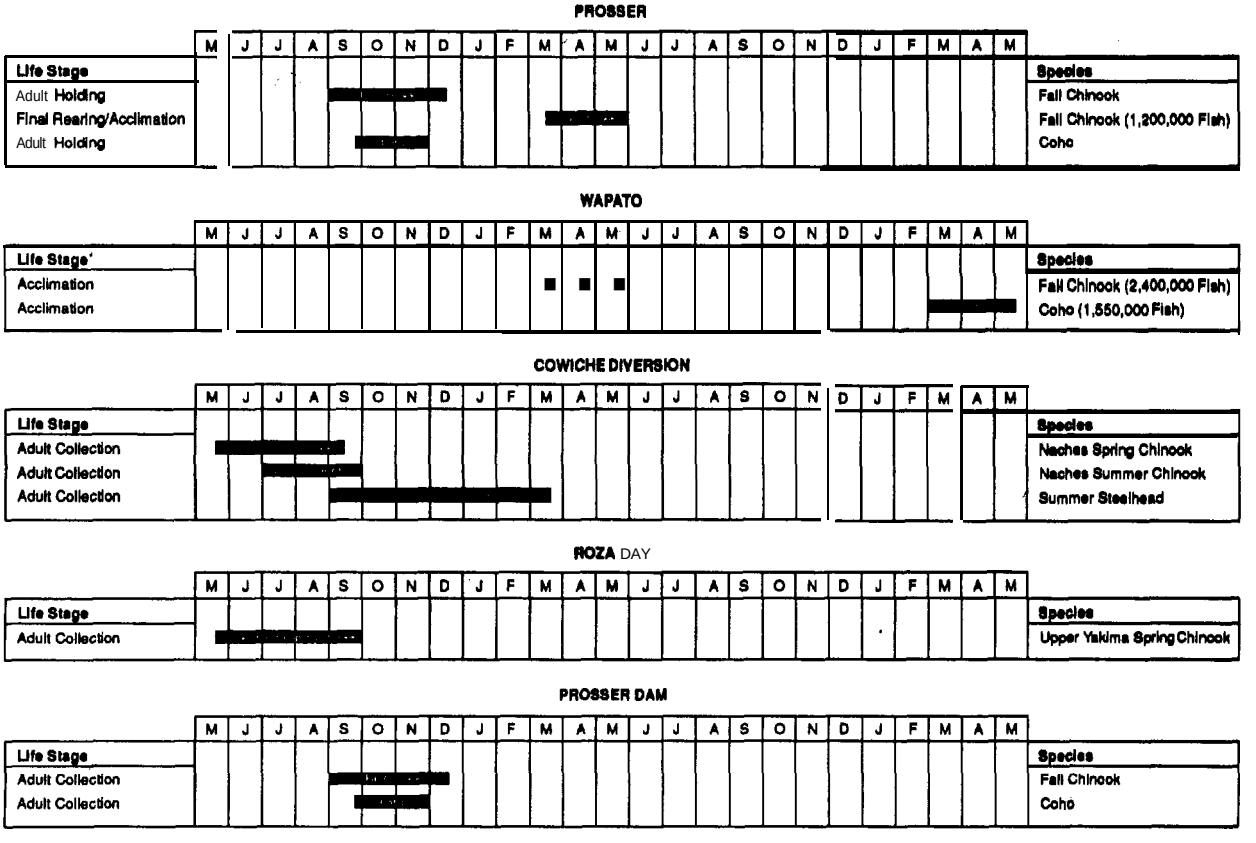


FIGURE 5. Yakima Subbasin Fish Culture Schedule by Site (from CH2M Hill 1990)



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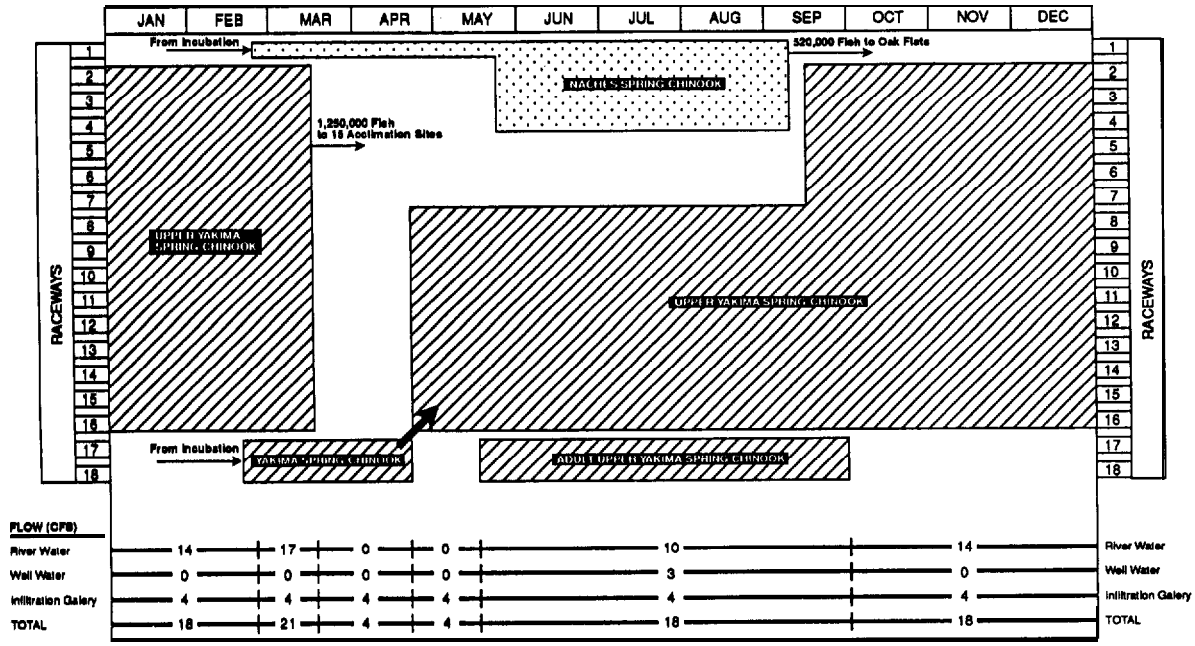

FIGURE 6. Cle Elum Central Hatchery: Upper Yakima and Naches Spring Chinook

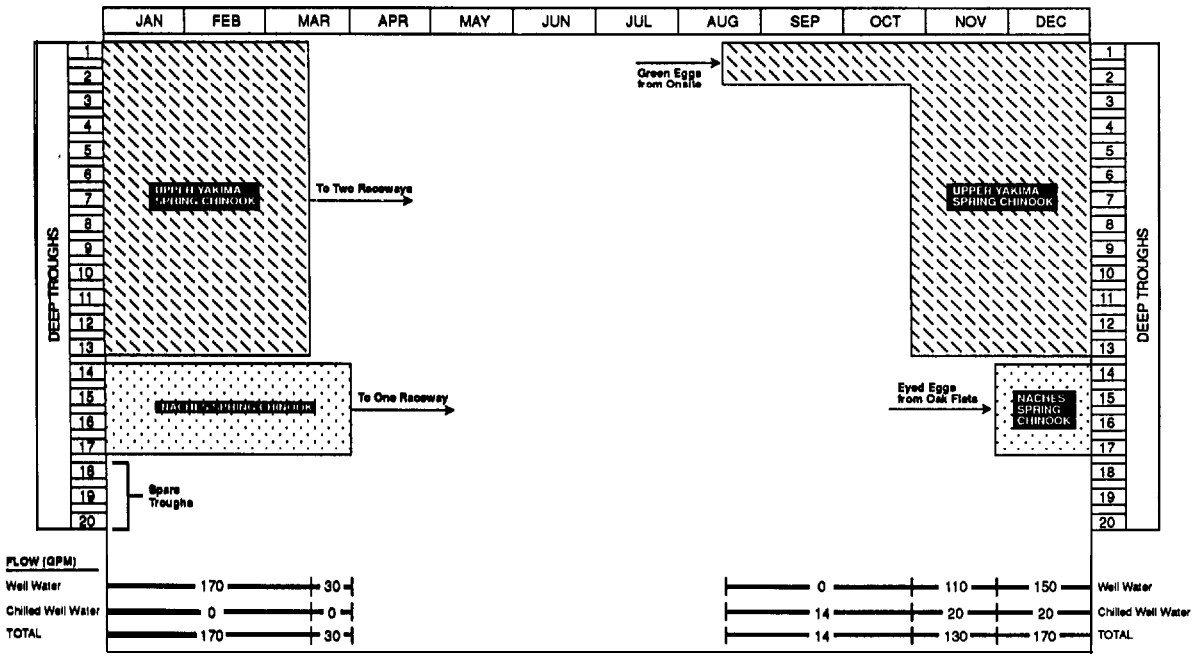

FIGURE . Cle Elum Central Hatchery: Upper Yakima and Naches Spring Chinook Incubation

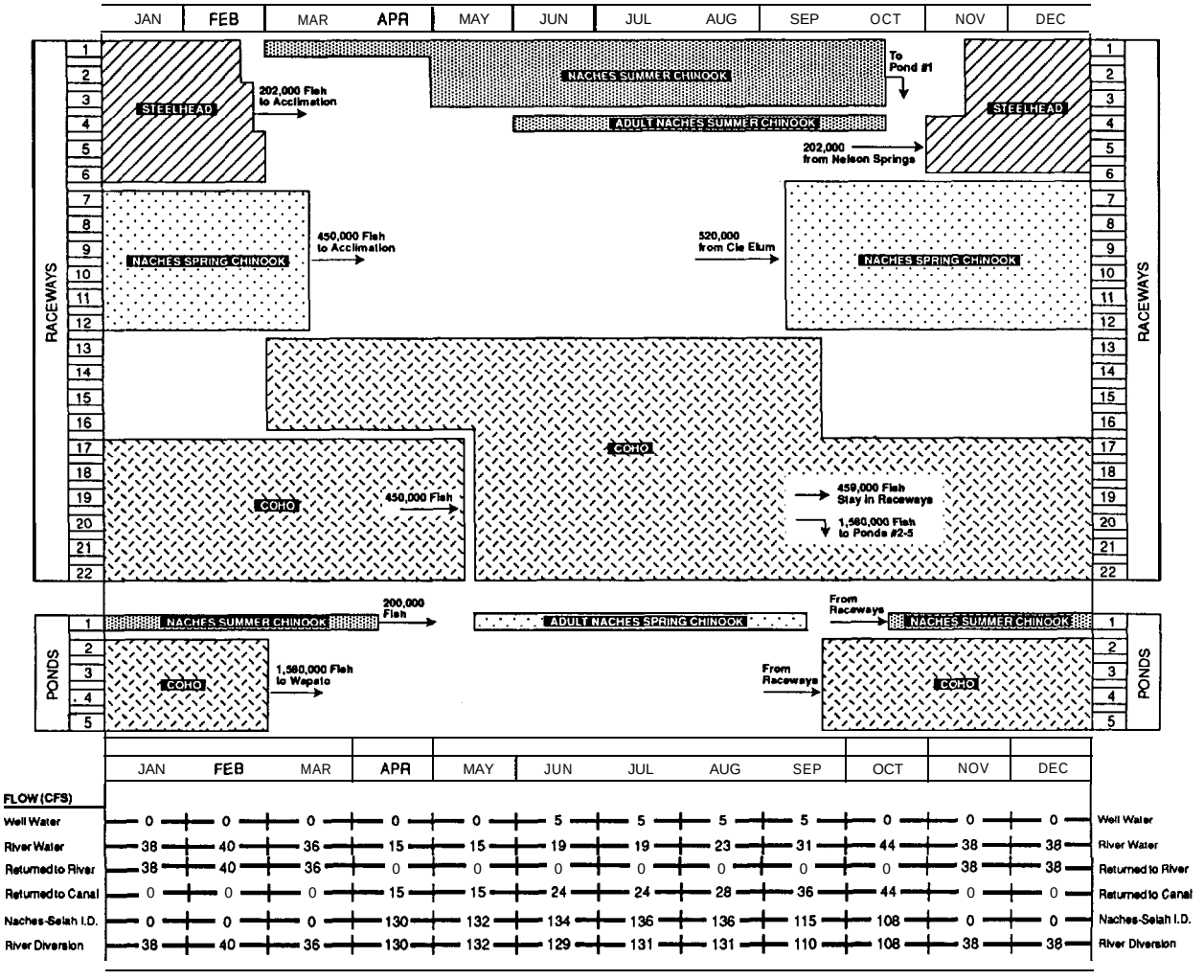

FIGURE 8. Oak Flats Central Hatchery: Naches Spring Chinook, Summer Chinook, Coho, and Steelhead Rearing

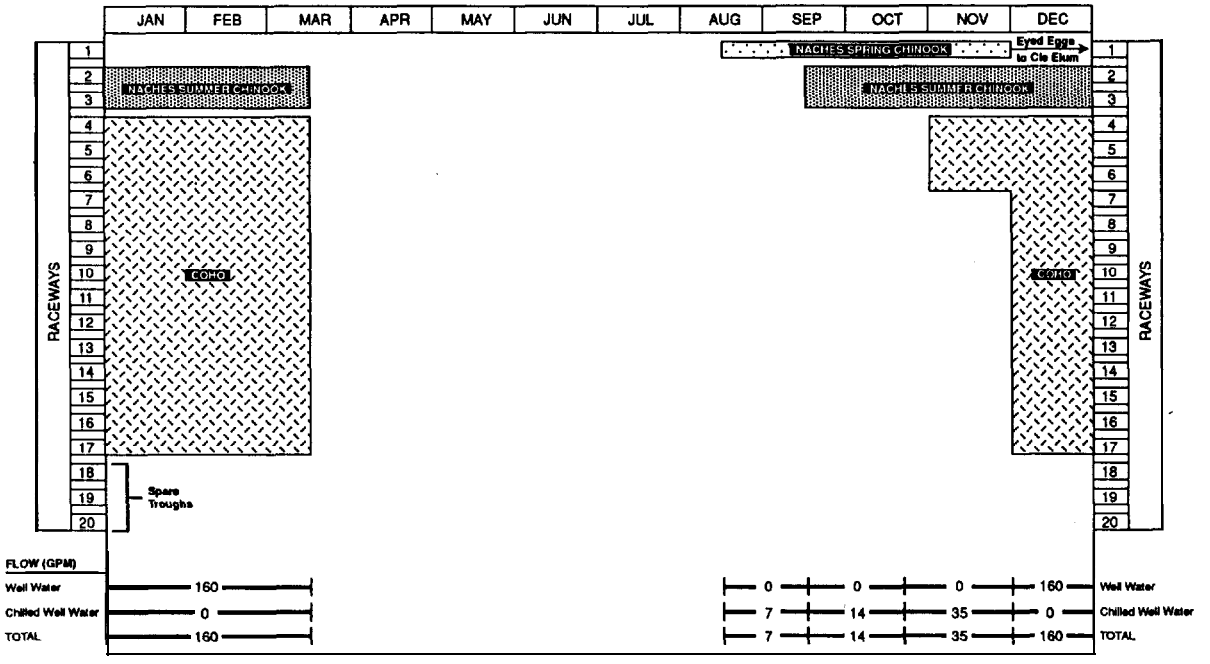

FIGURE 9. Oak Flats Central Hatchery: Naches Spring and Summer Chinook and Coho Incubation

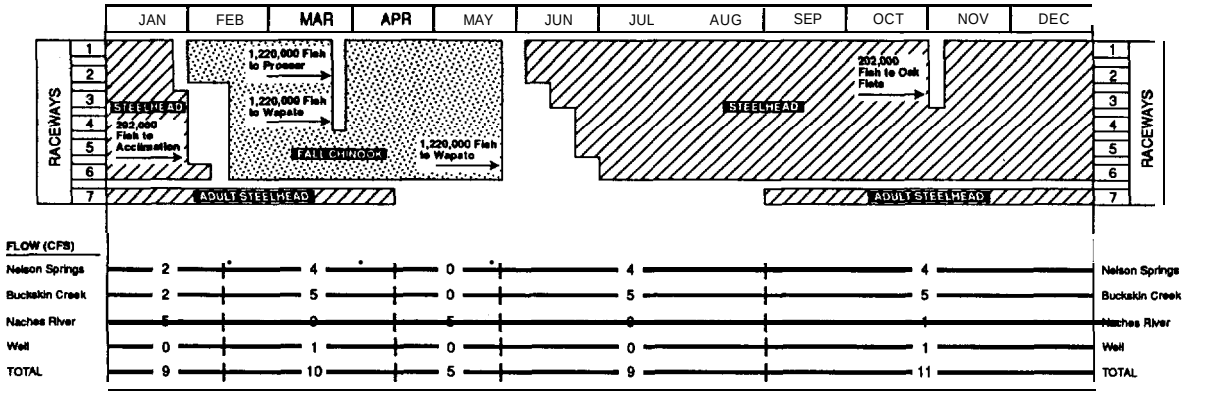

FIGURE 10. Nelson Springs Central Hatchery: Fall Chinook and Steelhead Rearing

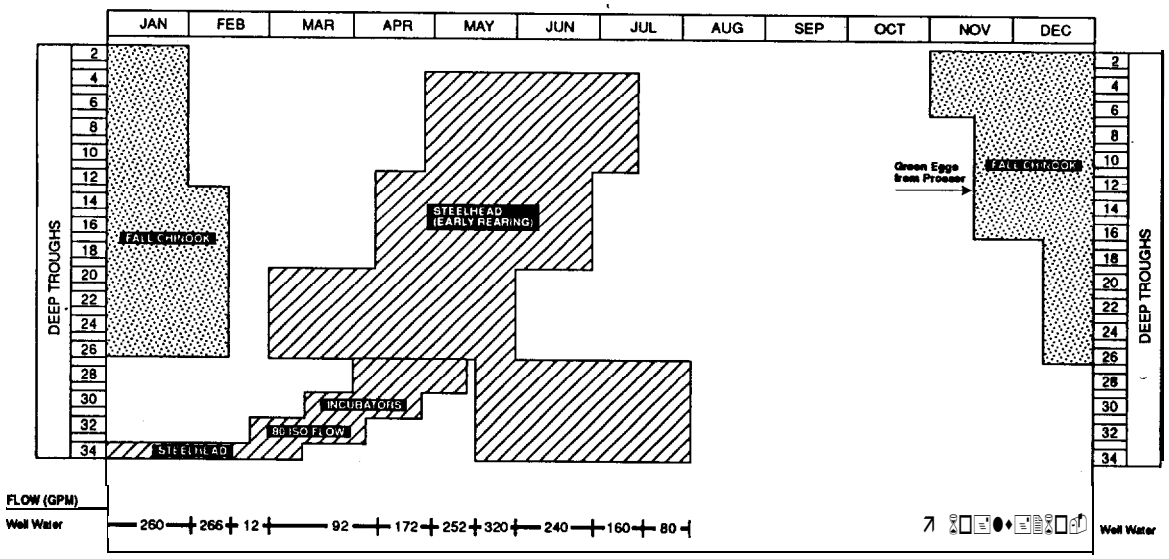

FIGURE 11. Nelson Springs Central Hatchery: Fall Chinpok and Steelhedd Incubation

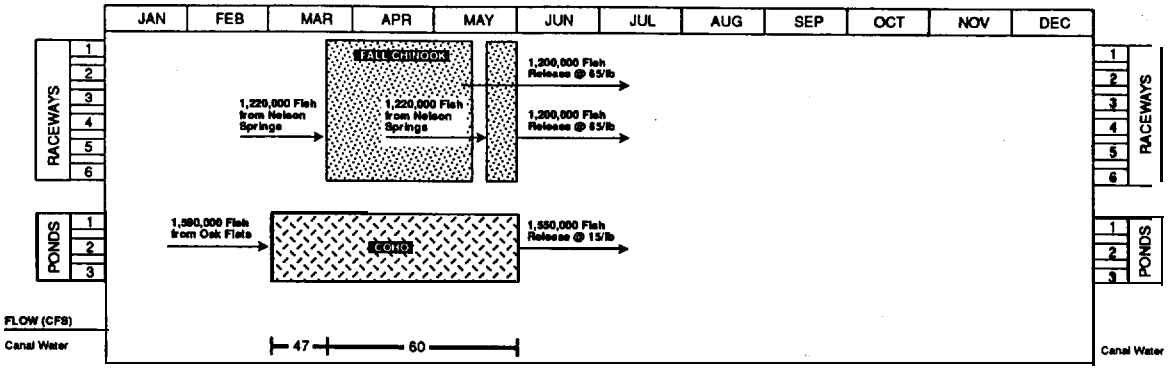

FIGURE 12. Wapato Satellite Site: Fall Chinook and Coho Acclimation

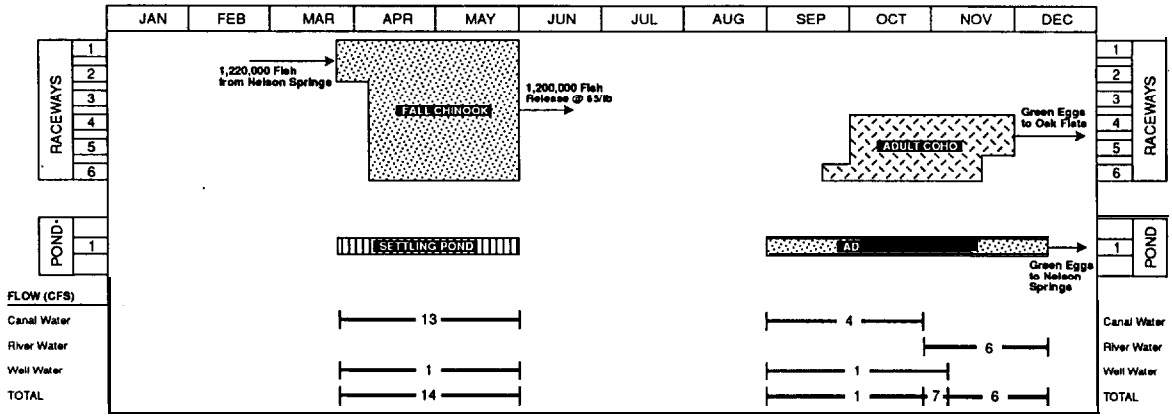

FIGURE 13. Prosser Satellite Site: Fall Chinook Adult Holding and Acclimation, Coho Adult Holding

No fish will be released directly from the Cle Elum facility. The 1,150,000 upper Yakima spring chinook reared at the Cle Elum facility will be outplanted to 15 acclimation ponds scattered throughout the upper Yakima drainage.

The Oak Flats site was chosen as the central hatchery facility for Naches spring and summer chinook, and for all coho production. Final rearing of half the planned steelhead production will also occur at this site. Production plans at Oak Flats include:

1. adult holding, early incubation (to the eyed stage), and final rearing of 450,000 Naches spring chinook
2. adult holding, incubation, and complete rearing (rearing to smolt) of all (200,000) summer chinook
3. incubation and complete rearing for all (2,000,000) coho
4. final rearing for half (200,000) of the total production of 400,000 steelhead.

Naches spring chinook smolts will be transferred to six ponds in the Naches drainage where acclimation and volitional release will occur. The steelhead will be transferred to five pairs of acclimation ponds in the Naches drainage, and one pair in the Toppenish Creek drainage (12 ponds total). Half of these steelhead ponds will receive fish from Oak Flats, and half from the Nelson Springs facility (see' below). Three quarters of the coho smolts will

be moved to three large ponds at Wapato Dam for acclimation and release, while the remaining quarter will either be released on-station (at Oak Flats), or trucked to release sites on Naches tributaries. Summer chinook smolts will be acclimated and released on-station as yearling smolts.

The Nelson Springs facility is located at the confluence of Buckskin Creek and Nelson Springs. This site was selected as the central hatchery for fall chinook and summer steelhead. The Nelson Springs site will provide for adult holding and early incubation (to the eyed stage) of all steelhead produced by the YKPP. In addition, 200,000 of the total of 400,000 steelhead smolts to be produced by the YKPP will be reared at this site. Fall chinook will also be incubated and reared at this station. A total of 3,600,000 fall chinook will be hatched and reared to pre-smolt at Nelson Springs. Fall chinook pre-smolts will be transferred to twelve raceways at Wapato Dam and six at Prosser for final rearing and release.

The acclimation ponds for spring chinook and summer steelhead are central to the YKPP supplementation program. These ponds will allow experimental groups of fish to recover from stress, possibly to acquire adaptive behavior patterns (such as predator avoidance or natural feeding behavior), and to imprint on cues from the general vicinity of the pond. It is expected that substantial numbers of acclimated smolts will return as spawners to the general vicinity of the acclimation ponds. Fifteen acclimation ponds in five clusters of three each were described for upper Yakima spring chinook in the plan developed by EDWG. The plan for acclimation of the Naches spring chinook included three clusters of two ponds each, The plan developed for summer steelhead includes six clusters of two ponds (five pairs in the Naches drainage and one pair in the Toppenish Creek drainage). Locations for these ponds are shown in Figure 3. A standardized acclimation pond was designed to accommodate the various experimental groups in the program. The groups are made up of either 33,000 summer steelhead at 7 per pound or 75,000 spring chinook at 15 per pound. It should be noted that acclimation is planned for coho and fall chinook as well. Three large acclimation ponds at Wapato Dam will be used to acclimate coho. Fall chinook smolts will be acclimated in the 12 raceways at Wapato Dam and the six

raceways at Prosser Dam. The total release of acclimated smolts in the lower Yakima River will include 1.5 million coho and 3.6 million fall chinook.

2. Klickitat Salmon and Steelhead Facilities

The Klickitat central facility is designed to meet the hatchery goal of enhancing production of spring chinook and summer steelhead. Biological criteria have been used to estimate requirements for the water system, adult holding space, number of incubation units, rearing space, and transportation and release methods. The biological criteria address the number and type of rearing containers and related support requirements. Each phase from adult capture to the transfer of juveniles into acclimation ponds has been addressed.

Fish production goals at the 10th year of operation are 3,000,000 spring chinook and 250,000 summer steelhead smolts. Spring chinook will be released at 15 per pound and steelhead at 9 per pound.

Cascade Springs is the planned location for the central facility and will include operations for adult holding, spawning, egg incubation, rearing, and acclimation and release. Five other sites were considered for some form of facility development: White Creek, Summit Creek, Klickitat WDF Station, Wonder Springs, and Indian Ford Springs. Acclimation sites in the upper Klickitat subbasin will receive fish from the central facility for short-term holding and rearing prior to release. Trapping and hauling sites include the Falls 5 Fishway, Lyle Falls, the WDF Klickitat Hatchery, and the Castile Falls Fishway. Locations of these facilities are shown in Figure 14.

Water for the Klickitat Hatchery will come from three sources: Cascade Spring, Kidder Spring, and the Klickitat River. Collectively, these sources meet the quantitative and qualitative needs of the facility.

E. PROJECT COST ESTIMATES

Total costs through for the Yakima and Klickitat Projects through March 1, 1990, were about $8,400,000. This value includes costs through FY-89 ($6,186,000) and current obligations for FY-90.

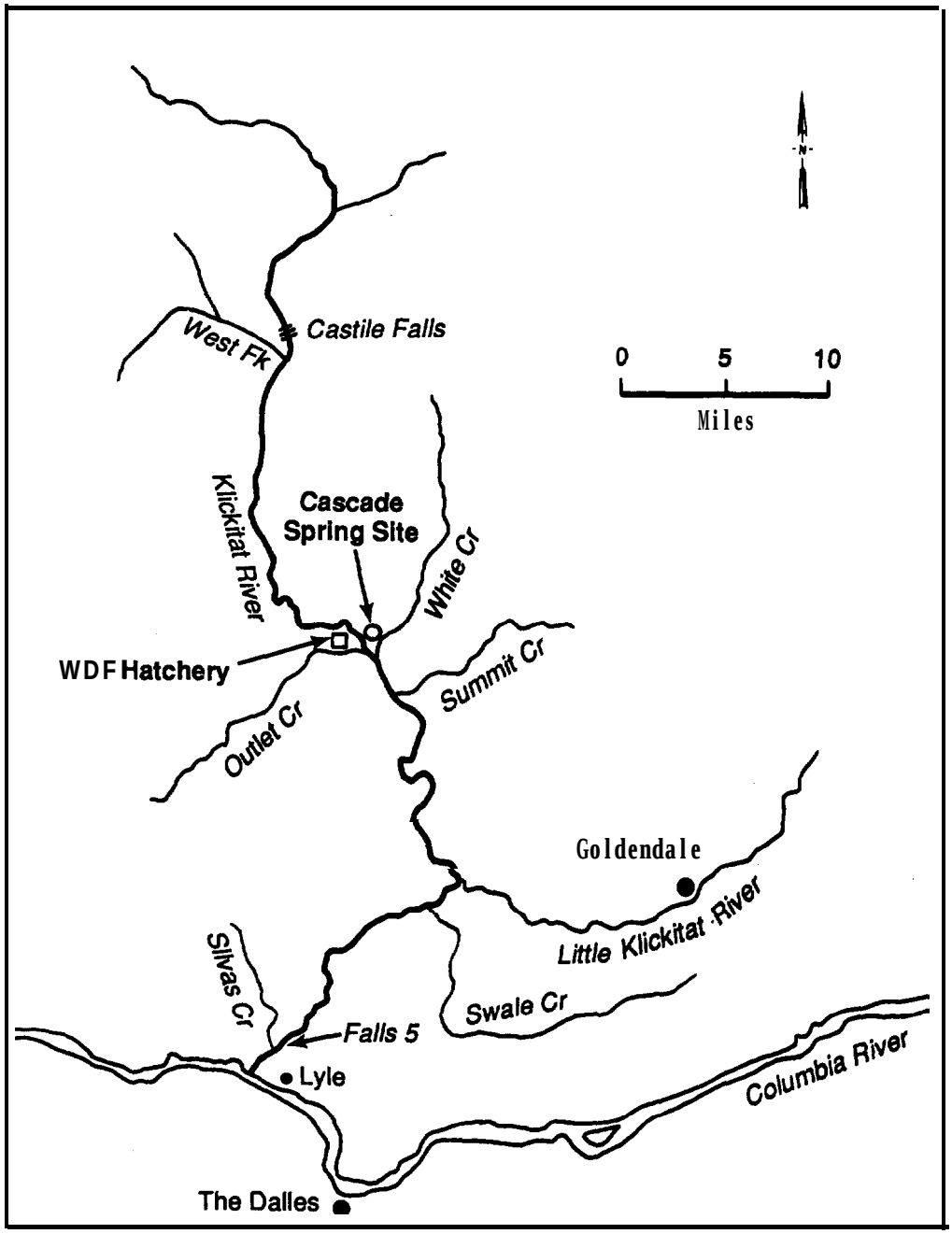

FIGURE 14 Klickitat Subbasin

1. Yakima River Facilities

The total costs estimated for construction of the Yakima River salmon and steelhead facilities (i.e., central hatcheries, satellite facilities, acclimation sites, adult and juvenile trapping facilities) is $31,434,000 (Table 5). This estimate includes an estimated 25% for engineering, legal,

TABLE 5. Yakima River Subbasin Salmon and Steelhead Facilities Capital Cost Summary (January 1990 Dollars)

Central Hatcheries	
Cle Elum	$5,160,000
Oak Flats	6,216,000
Nelson Springs	2,647,000
Satellite Facilities	
Wapato	2,154,000
Prosser	1,390,000
Acclimation Sites	
Spring Chinook (17 sites)	3,060,000
Steelhead (8 sites)	1,440,000
Chinook/Steelhead (4 sites)	1,000,000
Adult Trapping Facilities	
Roza	875,000
Cowiche	625,000
Prosser	80,000
Juvenile Trapping Facilities	
Oak Flats	390,000
Roza	110,000
Prosser	0
SUBTOTAL	25,147,000
Engineering Legal and Administration Costs (25%)	6,287,000
TOTAL	$31,434,000

and administrative costs, but does not include costs for escalation or local sales tax. Land acquisition costs for the three central hatcheries and the two satellite sites are estimated to be an additional $500,000. No land acquisition costs is available for the acclimation sites or the adult and juvenile trapping facilities. A more detailed breakdown of costs are given in Appendix C.

2. Klickitat Facilities

The total cost for construction of the Klickitat Hatchery, including five acclimation sites and fees for design and construction engineering, legal and administrative fees, is estimated to be $9,040,000. This value was determined using estimates of quantity and unit costs of materials and labor.

The total cost also includes contractor overhead and profit, a design engineering and construction management fee, and administrative and legal costs. Details of costs and implementation schedule are summarized in Appendix C.

The Klickitat Hatchery construction can be staged into two or three phases. The first stage would be to complete the site work and construct the building, complete raceways required for year 1 of operation, and complete sedimentation ponds and water intake facilities. This construction schedule would allow for operation of the facility the first year. Additional raceways and rearing ponds could be built during Phase 2 of the construction. The steelhead program at this station is planned to be a E-year smolt program, which allows for staged construction. Estimates of yearly construction costs would change depending upon the timing of these construction events.

IV. PROJECT ANALYSES

A. ANALYSIS OF WATER SUPPLY

Task Two of the Council's conditional approval of the YKPP was to conduct a technical analysis of water supplies available for fish production in the Yakima and Klickitat River subbasins. The primary objective of the analysis was to evaluate the adequacy of water supplies in the two subbasins for increasing both natural and artificial production. The USBR entered into an Interagency Agreement with BPA to conduct this water supply analysis in May, 1988. An initial review of existing information revealed that insufficient data was available on water quality and quantity characteristics to conduct such an evaluation. Therefore, field studies were conducted from May 1988 to October 1989 by the USBR to gather some of the needed data. Additional information was obtained from others ongoing efforts in both subbasins by cooperating entities. This section summarizes data collected from these studies and other that are described or cited in Appendix B (USBR 1990).

1. Backsround

Water supply for the Yakima River and irrigated croplands comes from natural flows, groundwater, storage, and return flows. Six federal reservoirs help regulate this supply. Other features affecting the amount of water available for fish production include diversion dams, irrigation returns, three hydroelectric generating plants, irrigation canals, laterals, and pumping plants. About 75% of the present storage capacity of the Yakima subbasin is in the upper Yakima drainage, with the remainder in the upper Naches drainage. These reservoirs are the main suppliers of storage waters to irrigation districts in the lower valley. Return flows from irrigation developments in the upper valley provide a major portion of the water in the lower Yakima River during the irrigation season (late March through mid-October). Water use practices in the Yakima River conflict with anadromous fish production because irrigation demand represents about two thirds of mean annual runoff, and almost a third of the annual runoff is stored in reservoirs in the upper drainage. Problems take two forms: low instream flows in various reaches during the period of reservoir refilling (October through late June or

early July), and excessive instream flows during the later part of the irrigation season (July through mid-October).

In contrast, no major storage reservoirs have been constructed in the Klickitat subbasin and total diversions represent a small proportion of total subbasin runoff. River flows are not considered a problem for anadromous fish production because they follow a largely natural runoff pattern.

Anadromous fish stocks currently using the Yakima subbasin include spring and fall chinook salmon, coho salmon, and steelhead trout. Native coho are extinct (although small numbers of non-native hatchery coho have spawned in recent years), and native runs of summer chinook and sockeye salmon are extinct. Each of these stocks has a range of instream flow requirements that vary as a function of life history stage (e.g., spawning migration, spawning, egg incubation, rearing).

2. Methods

The water supply analysis study team compiled data from five general areas: 1) stream hydrology, 2) stream description, 3) facility water supplies, 4) fish habitat, and 5), water quality. Summary and analysis of streamflows was based on historic data, field measurements, and computer simulations of the Yakima River storage system. Detailed field surveys were conducted by USBR biologists and hydrologists to identify constraints to anadromous fish production attributable to instream flow and migration barriers. Existing data on surface water was reviewed and judged to be adequate for analysis However, in order to estimate groundwater potential it was necessary to conduct geophysical surveys, and drill and pump test new wells, at the proposed site of each of the incubation and rearing facilities.

Information on fish habitat quantity and quality was developed from several sources including instream flow methodology (IFIM analysis), stream description surveys, and information obtained from subbasin planning efforts. The natural production potential of the anadromous fish habitat in both subbasins was estimated with the smolt density model used in subbasin planning.

Water quality data were obtained from the Environmental Protection Agency (EPA) data storage system (STORET) and supplemented by new data when

necessary. Water quality data was evaluated against criteria developed by the Alaska Department of Fish and Game for salmonid aquaculture. Suitability of river reaches and tributary streams for salmon rearing, passage, and harvest were evaluated using Washington State standards for Class B streams, U.S. Department of the Interior criteria for protection of freshwater aquatic life, and general temperature guidelines proposed by Bell (1973).

3. Facilities' Water Supply

Hatchery facilities have been proposed for five sites in the Yakima River subbasin (Prosser, Wapato Canal, Cle Elum, Oak Flats, Nelson Springs) and one site in the Klickitat subbasin (Cascade Springs). The adequacy of both surface and ground water supplies for each of these sites is summarized in Figure 15. The quantity of available surface water is probably adequate at all sites. Groundwater supplies may need additional development at three of the sites. Water quality parameters of concern included temperature, low sodium concentrations, and elevated concentrations of nitrate, chloride, and several metallic ions (i.e., aluminum and manganese). Detectable levels of several pesticides were noted at one site downstream of the lowermost proposed facility (Prosser). It is significant that natural production in the vicinity of proposed facilities does not appear to be constrained by water quality. Further review of data is needed to determine the applicability of state of Alaska standards to the YKPP.

4. Stream Description

Water use and supply patterns, water quality characteristics, and general habitat descriptions were obtained for stream reaches and tributaries to evaluate their potential for anadromous fish production. Evaluations considered current use by anadromous salmonids and their life stage requirements.

a. Yakima Subbasin

Major constraints to anadromous fish production for different areas of the Yakima subbasin are summarized in Table 6. Flow constraints are numerous and include low spring flows in the upper Yakima that can, directly or indirectly, kill newly-emergent fry; low spring flows in certain reaches of

Facility Site	Water Supply	Water Quality	Water Quantity
Prosser	Surface Water	◒	0
	Ground Water	0	0
Wapato Canal	(Surface Water)	0	0
Cle Elum	Surface Water	0	0
	Ground Water	0	0
Oak Flats	Surface Water	○	0
	Ground Water	◒	0
Nelson Springs	Surface Water	◒	◒
	Ground Water	◒	◒
Cascade Springs	River Water	○	0
	Ground Water	◒	0

0 -Adequate
◒ - Marginal or Further Evaluation Needed

FIGURE 15. Summary of Adequacy of Water Quantity and Quality for the Proposed YKPP Facilities

the middle river that exacerbate losses of outmigrating smolts; low winter flows in the middle river that adversely affect overwinter survival of pre-smolts; and summer flows in the upper and middle river that are too high for optimal rearing.

Water quality constraints include high summer temperatures in the lower river that could prevent passage and rearing; a high suspended sediment load in the lower river that degrades spawning habitat; and elevated concentrations of chloride, nitrate, aluminum and manganese in the lower river whose impact on natural populations appears to be minimal. It should be noted that water quality problems are largely restricted to the lower 40% of the river, roughly from Sunnyside Dam to the mouth, and it is only in this reach that water quality represents a significant constraint on anadromous fish production.

Passage problems include adult migration barriers, primarily at impassible diversion dams on tributaries; hazards to juvenile passage, primarily in the form of unscreened or poorly screened irrigation ditches; and reaches of seasonally low instream flow, primarily below larger diversions on both the mainstem an a number of tributaries, that impair the passage of both juveniles and adults.

Summary of Major Constraints to Anadromous Fish Production in the Yakima River Basin and Stocks Affected. Additional restraints may exist in these and other areas, but will tend to reduce production rather than prevent or seriously impact it (from USBR 1990)

Stream Reach or Tributary	Major Constraint	Affected Stocks
Yakima River from Mouth to Prosser Dam	Flow, WQ	FC, SuC, SpC, Co, STDH
Corral (Canyon) Creek	Adult & Juvenile Passage	Co, STHD
Spring/Snipes Creek	Flow, WQ, Pesticides	Co, STHD
Sulphur Creek	WQ, Flow	Co, STHD
Satus Creek	Flow	spc, co
Toppenish/Simcoe Creeks	Culverts, Adult & Juvenile Passage	FC, Co, STHD
Ahtanum Creek	Adult & Juvenile Passage	SpC, Co, STHD
Wide Hollow Creek	Adult & Juvenile Passage, WQ	Co, STHD
Wenas Creek	Flow, WQ, Adult & Juvenile Passage	SpC, Co, STHD
Wilson Creek	Adult & Juvenile Passage	SpC, STHD
Manastash Creek	Adult & Juvenile Passage, Flows	SpC, STHD
Taneum Creek	Flow	SpC, STHD
Swauk Creek	Flow, WQ, Juvenile Passage	SpC, STHD
Teanaway River	Juvenile Passage, Flow	SpC, STHD
Little Creek	Juvenile Passage, Flow	STHD
Big Creek	Adult & Juvenile Passage, Flow	SpC, STHD
Cabin Creek	Adult & Juvenile Passage, Flow	SpC, STHD

(TABLE 6 continued).

Stream Reach or Tributary	Major Constraint	Affected Stocks
Cowiche Creek	Adult & Juvenile Passage	SpC, Co, STHD
Tieton River	Flow	SpC, Co, STHD

KEY:

FC = Pall Chinook
SuC = Summer Chinook
SpC = Spring Chinook
Co = Coho
STHD = Steelhead
WQ = Water Quality

It is important to note that most of the constraints to anadromous fish production can be reduced or eliminated with improvements (Appendix B).

b. Klickitat Subbasin

The major constraints to anadromous fish production in the Klickitat subbasin are adult passage and flow (Table 7). Steelhead, spring chinook, and coho salmon were the primary stocks affected. Several falls block anadromous fish access to upper portions of the Klickitat River and its tributaries. Low seasonal flows also restrict year-round production of anadromous fish in tributary streams. Most tributary streams were not suitable for supplementation of the limited production potential of existing habitat. Water quality conditions were not determined to be a major constraint in the Klickitat subbasin and improvements were identified to increase production potential (Appendix B).

B. GENETIC RISK ASSESSMENT

An essential aspect of the Council's commitment to genetic conservation is the stipulation that genetic risk be assessed in planning for any production project under the Council's purview. Accordingly, a genetic risk assessment was conducted to address Task 5 of the Council's conditional authorization to BPA to implement predesign work for the YKPP. This section summarizes information presented in fulfillment of

TABLE 7. Summary of Constraints to Anadromous Fish Production, Natural Production Potential, and Suitability for Inclusion in Hatchery Planning for the Klickitat River and Selected Tributaries (from USBR 1990).

Stream Reach or Tributary	Major Constraint	Affected Stocks
Klickitat River from Castile Falls to Headwaters	Adult Passage	SpC, Co, STHD
Snyder Creek	Adult Passage, WQ	Co, STHD
Swale Creek	Flow	Co, STHD
Little Klickitat River System	Adult Passage, Flow, WQ	SpC, Co, STHD
Summit Creek	Adult Passage	Co, STHD
Outlet Creek	Adult Passage	Co, STHD
Elk Creek	Adult Passage, Flow	Co, STHD
Deer Creek	Adult Passage	Co, STHD
Bacon Creek	Adult Passage	Co, STHD
Dairy Creek	Adult Passage	Co, STHD
Big Muddy Creek System	WQ	Co, STHD
Cunningham Creek	Adult Passage	Co, STHD
Surveyors Creek	Adult Passage	Co, STHD
Soda Springs Creek	Adult Passage	Co, STHD
West Fork System	Adult Passage	Spc, Co, STHD
Chaparral Creek	Flow	Co, STHD
McCreedy Creek	Adult Passage	Co, STHD

KEY:

FC = Fall Chinook
SuC = Summer Chinook
spc = Spring Chinook
Co = Coho
STHD = Steelhead
WQ = Water Quality

the requirement that genetic risks be assessed. Greater detail is provided in Appendix A (Draft Yakima/Klickitat Production Project Genetic Risk Assessment).

This YKPP genetic risk assessment is preliminary for three reasons. First, a standard Council format for genetic risk assessment has not yet been established. Genetic risk assessment tools, including a software expert system, are being developed by the Council's MEG, but are not yet operational. Second, too little information is available on the fish stocks potentially at risk in the YKPP to permit a detailed risk assessment. This is especially true of the Klickitat subbasin, where relatively little research into stock structure has been done and population monitoring facilities are virtually nonexistent, but is also true of the Yakima subbasin. Knowledge of the substock structure of target species and runs is essential to a genetic risk assessment. The case of spring chinook illustrates this problem well. There are thought to be at least two substocks in the Yakima subbasin, but there could be several more. In the Klickitat subbasin, it is not even known if a wild spring chinook stock still exists. More detailed data on substock structure has been identified as a critical pre-facility informational need in the YKPP Experimental Design Plan.

The third and final reason this genetic risk assessment must be considered preliminary is the YKPP's emphasis on adaptive management. As new information comes to light, either from direct experimentation or from population sampling, YKPP operations will adapt to the new information, shifting operational parameters such as hatchery production levels, stocking rates, and broodstock collection procedures. This can have a major impact on the genetic risks entailed in the production effort. The genetic risk assessment will have to be revised as genetic risks shift in response to changes in YKPP production procedures.

Despite the lack of information on which to base a detailed assessment of genetic risk, and the certainty of future revisions, it is possible at this point in planning to make a careful, well-researched statement of genetic risks posed to salmonid stocks by the YKPP.

1. Cateaories of Genetic Risk

Current genetic risk assessment planning by MEG has identified three types of genetic risk: 1) extinction; 2) loss of within-population variability; and 3) loss of population identity (between population variability). Extinction represents the most extreme type of risk. Once a population is extirpated, all its genetic variability is irretrievably lost and any genetic uniqueness represented by that population is gone. Typical potential causes, acting alone or in combination, for salmonid populations in the Northwest are overharvest, passage difficulties, and habitat degradation. Extinction is less of a risk in hatchery operations, but scenarios can be envisioned in which hatcheries could play a role in extinction. For example, extinction would result if hatchery egg takes cause wild spawners to fall below critical numbers and the hatchery fails. A disease outbreak in the hatchery could also cause the population to fall below a minimum viable size. Another possibility is ecological displacement by large numbers of hatchery fish causing the wild population to fall below the minimum viable number.

The second type of risk, loss of within-population variability, is commonly associated with hatchery production. There are actually two major categories of Type 2. Type 2a risk is loss of variability due to genetic drift, a problem common to all finite populations. If the population is large enough, this loss through drift is compensated for by the creation of new variability by mutation, but captive populations are generally too small for this compensation to occur. The result is a gradual loss of variability and concurrent increase in homozygosity.

Loss of variability is related to effective population size, rather than census population size. In an ideal population, the two numbers are the same, but differential contributions of the two sexes to the progeny, varying family sizes, and annual variation in number of spawners often makes the effective size of a population much smaller than the census number. This is the most common type of genetic risk imposed by hatcheries.

Type 2b risk is loss of variability due to nonrandom sampling of a population in collecting broodstock. Significant portions of the stock's genetic variability may thus be omitted from the cultured stock. This

phenomenon is often called "founder effect." It can easily occur in hatchery operations. Typical situations include taking eggs from the earliest spawners until a quota is met, rather than taking eggs from throughout the entire spawning period; or using jacks as spawners in proportions much lower than their occurrence in the spawning population.

The third type of genetic risk is loss of between-population variability, which can also be described as loss of population identity. If two populations are mixed, there may be no loss of genetic material overall, but the genetic distinctness of the two populations, based on the genes they separately contained at particular frequencies, will be lost. The mixing will cause a recombining of genes that had formerly occurred in high fitness combinations called "coadapted complexes." The new combinations of genes may result in lower fitness in the mixed population, a phenomenon called "outbreeding depression" or "maladaptation."

Loss of population identity is a common risk in hatchery operations. For example, stock mixing is often deliberately done to meet egg-take requirements, and straying can be exacerbated by particular release and transportation strategies. Another possibility is genetic swamping of a wild population with naturally spawning hatchery fish from another stock.

A fourth type of genetic risk, domestication selection, needs to be considered in assessing the impact of hatchery operations on salmon and steelhead. Hatcheries, despite attempts to avoid causing genetic change in the cultured stock, may impose new selection regimes on the fish in the course of standard fish culture techniques, causing increased fitness in the hatchery environment, but decreased fitness in the wild.

2. Minimizing Genetic Risk in Anadromous Salmonid Production Programs

Genetic risk can be minimized considerably by careful management of fisheries and hatchery operations. Type 1 risk, extinction, often can be minimized simply by reducing harvest. This can, however, present problems, as salmonids are often harvested in mixed-stock fisheries, and targeting very strong stocks can harvest weaker stocks at excessive rates. Several potential solutions to this problem exist. The first is to target stocks specifically by harvesting in terminal areas; the second is to manage the fishery for

protection of the weak stocks by monitoring harvest by coded-wire tags or GSI. Extinction due to excessive egg take for hatchery operations can be prevented by limiting the use of wild brood stock to a specified percentage of the population based on solid demographic information.

Considerable control can be exerted over Type 2a risk, loss of within-population variability due to genetic drift. The key is accurate estimation of effective population size, which requires Information on age structure, sex ratio, and number of spawners. Once effective population size has been estimated in non-supplemented populations, escapement must be controlled to keep the effective number sufficiently high to avoid excessive loss of genetic variability. This will probably require management of the harvest. Attention has to be paid to spawning protocols in hatcheries, in addition to considering the demographic factors already listed. It is possible, with appropriate hatchery mating schemes, to contrive a larger effective population size than would otherwise have occurred in an usupplemented population spawning naturally.

Type 2b risk or loss of variability due to founder effect is theoretically simple to minimize. Broodstock can be selected by random sampling, taking care that enough fish are sampled that'variability is not lost. However, this can be quite difficult in practice. For example, collecting spawners throughout a run may require taking excess fish to Insure that the egg-take goal is met, and the more fish that must be taken, the greater the impact on the wild spawners. A possible, but as yet unexplored, way to solve this problem is through partial spawning of fish In the hatchery and then releasing them to the wild.

Type 3 risk, the loss of population identity, can be minimized by first obtaining a detailed knowledge of the geographic distribution of all distinct substocks impacted by the production program, and then by avoiding substock mixing. A thorough genetic survey of the populations subject to risk should have a high priority in pre-facility planning. Stock structure and stock-specific distribution patterns must be preserved. Broodstock collection must be done in sufficiently terminal locations to avoid a mixed-stock collection, and juveniles must be released in "ancestral" drainages only, Mixing of stocks by using fish from one stock to make up production shortages in

another, a relatively common hatchery practice, must be avoided. Finally, straying must be monitored, both within and outside the subbasin.

Type 4 risk (Le., domestication selection) can be minimized in theory by restricting exposure to elements of the hatchery environment that impose selection pressures different from the natural environment. However, attempting to minimize the selective influence of the hatchery can also conflict with production goals. One possible approach to minimizing hatchery influence, which is planned for some new hatchery operations in the Columbia Basin, is marking all hatchery fish and taking only naturally produced (unmarked) fish as broodstock. The intent is to alternate generations of selective effects of the hatchery environment with generations of selective effects of the wild environment. This method has not yet been tested. However, whatever safeguards may be employed, it is essential that a monitoring and evaluation program be developed to track the possible development of stocks impacted by domestication selection.

3. General Procedures for Minimizina Genetic Risk

The commitment of YKPP planners to minimizing genetic risk is well illustrated by the fact that the entire project is designed as an experiment, the central hypothesis of which is ". ..new artificial production in the Yakima and Klickitat subbasins can be used to increase harvest and to enhance natural production without adversely affecting genetic resources." To this end, certain genetic conservation protocols are built into the project.

a. Substock Identification

A detailed understanding of stock structure and distribution is an integral part of planning to maximize genetic conservation. Substock identification, including development of improved substock definition techniques, has thus been identified as a critical YKPP pre-facility research activity. The intent is to analyze electrophoretic and scale pattern data from all major spawning aggregations of targeted stocks: spring chinook in both the Yakima and Klickitat subbasins; summer steelhead in both subbasins; and fall chinook in the Yakima subbasin. Klickitat winter steelhead, which are not targeted for supplementation, will also be sampled. Sampling of most spawning aggregations will be repeated annually through one full generation

cycle (4 to 5 years) to understand annual fluctuations In gene frequencies. Hatchery stocks of chinook, steelhead, and rainbow trout that may have contributed to, or may still be contributing to, the genome of targeted YKPP stocks will also be electrophoretically analyzed. Populations with unique life history characteristics will also be analyzed electrophoretlcally.

b. Broodstock Manaoement

Broodstock management will be designed to minimize several types of genetic risk. Returning adults, including jacks, will be randomly taken at appropriate collection sites to minimize Type 2b risk. Effective population size will be maximized in the hatcheries by a variety of methods to minimize losses of variability due to genetic drift (Type 2a risk). For example, no more than 10% of an adult steelhead population and 20% of an adult chinook population will be taken for hatchery broodstock. Substocks will be individually cultured to minimize the possibility of stock mixing in the hatcheries. All supplementation fish will be marked, and marked fish will be excluded from broodstock collections to minimize the risk of domestication selection (Type 4 risk).

c. Genetic Monitoring and Evaluation

Long-term monitoring is required to assess the success of both the supplementation and the genetic conservation effort. Methodologies for YKPP genetic monitoring are still being developed, and will be continually improved. At this point, however, key elements appear certain. YKPP stocks will be periodically analyzed electrophoretically to examine genetic change at structural gene loci over time. Observed gene frequency fluctuations can then be compared with theoretical values based on effective population size calculations from routine production population monitoring. Fluctuating meristic asymmetry, a measure of developmental stability, will be analyzed on the same schedule. Fine-scaled fitness comparisons between hatchery and wild fish will be based on measurement of several survival and reproductive traits,

d. Genetic Refuaes

Two stocks in the Yakima subbasin, American River spring chinook and Satus Creek summer steelhead, will not be supplemented. Both stocks are characterized by high productivity and little or no hatchery ancestry.

American River spring chinook, characterized by a distinctive age structure and spawning timing, have also been characterized as a distinct substock within the Yakima Subbasin. Satus Creek and the American River will be managed as genetic refuges for these two stocks.

4. Genetic Risk Assessment for Taraet and Nontarget Stocks

A detailed dlscussion of the potential genetic risks posed to individual target and nontarget stocks in the Yakima and Klickitat subbasins, both under present management and under proposed YKPP management, is presented in Section 5 of Appendix A (Draft, Genetics Risk Assessment for the Yakima Klickltat Production Project).

C. ECONOMIC ANALYSIS

The proposed YKPP will have major impacts upon the economies of the project area. During the construction phase economic flows will arise from spending on materials, services, and labor. Upon completion of this phase of the program, expenditures associated with sport and tribal harvests will cycle through the local economies. A biological monitoring and experimentation program will also generate employment, spending, and income. This economic study Identified and measured the impacts of these activities on the project area economies, including estimating both initial spending and subsequent rounds of responding. The analysis did not weigh the economic benefits of projects against costs (i.e., determine net benefits), but it did generate estimatlons of economic flows and impacts.

The study region was comprised of three functional subareas: 1) Yakima and Kittltas counties, 2) Klickitat, Wasco (Oregon), and Hood River (Oregon) counties, and 3) Benton and Franklin counties. The Yakima/Kittitas region will experience the greatest economic impact because of the size and type of proposed hatchery facilities in the region, the size and nature of the local economies, and the interaction of economic flows. The time period covered in this study extended from the initial construction phase through the time corresponding to maximum sustained yield production.

The five major activities involved in this analysis were to develop models, gather and validate data, estimate direct and indirect impacts, and

interpret findings (Figure 16). Results of this study were based on the analyses of six economic models. The first four models (construction, O&M, monitoring and experimentation, and harvest) were direct impact models that converted physical and financial activities into dollar expenditures affecting each of the study counties. Each of these models provided estimates of direct impacts occurring from initial purchases from the economy that result from project expenditures. The remaining two models (input-output and econometric) were used to estimate the secondary effects upon the economy that resulted as direct expenditures caused by additional economic activities.

The purpose of economic analysis was to estimate the positive impacts of the YKPP upon the immediate regional economy. Three types of economic impacts, each of which captured one facet of change in regional economic activities, were defined for analysis. Direct impacts refer to the initial purchases within an economy that result from project activities. Examples include purchases for hatchery construction and equipment for harvesting, and expenditures for lodging by out-of-area experimental consultants. Indirect impacts are inputs from other business sectors resulting from the production and sales of goods and services. Changes in employment in industries that experience both direct and indirect impacts result in changes in income that are spent in the region to purchase consumer goods and service. This

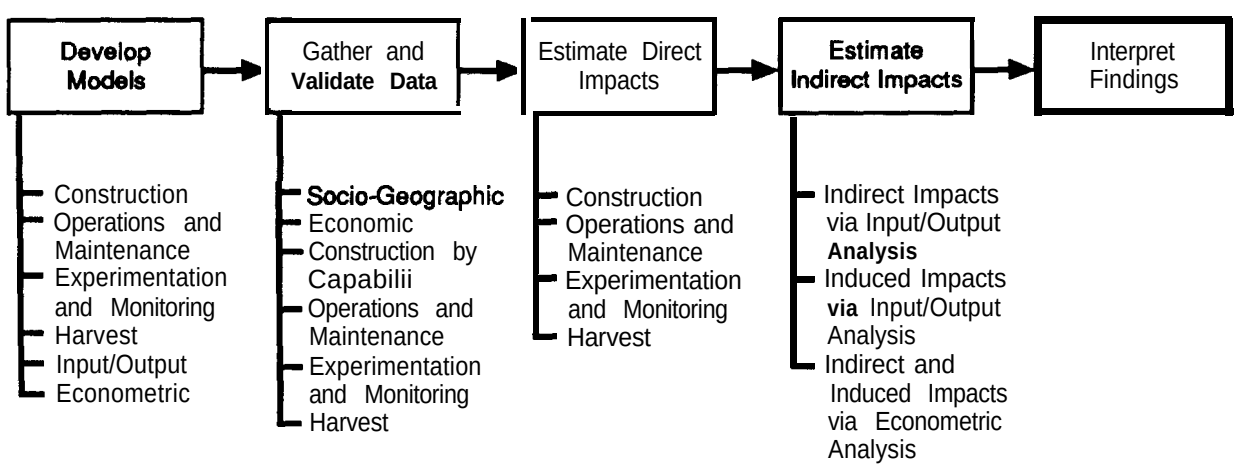

FIGURE 16. Overview of Procedures

income effect is the source of induced impacts. The total economic impact is the sum of all three levels of impact for each sector of the local economy. There is a multiplicative effect of a given direct impact, which results in greater total impacts. This so-called multiplier reflects the extent to which the initial expenditures recirculate through a local economy. To most accurately assess the multiplicative effect, estimates of the multiplier are often derived for each sector of the economy.

A computer model of the local economies was used to simulate local economic interactions. Two complementary methodologies were used to estimate indirect and induced impacts of the enhancement program. A modified version of IMPLAN (IMpact analysis for PLANning) model was initially used to simulate the linkages, as measured by the dollar value of purchases or sales among the various industrial and commercial sectors, of an economy. Six runs with the model developed impacts for the construction and harvest time periods and for each of three economic areas: 1) the total project area, 2) the Yakima subbasin, and 3) the mid-Columbia/Klickitat subbasin. This model has a high level of detail, which allows for estimates of industry-specific impacts.

A regional econometric model was used to quantify the key linkages between employment, income, and spending in a region. The magnitude and extent of these linkages was estimated using historical data on the operation of the regional economy. This model was developed to incorporate time-dynamic impacts that complement the more detailed, static results of of the input-output model. One variation used was a dynamic economic base model for Yakima, Kittitas, and Klickitat counties or the areas which will receive most of the direct impacts. A second econometric model was run to validate results obtained with the input-output model. A baseline model was created to predict the annual activity levels of the economy from 1990 through 2015. The model was then re-run to include the direct impacts of the fishery enhancement project. The differences in employment, income, and taxable sales arising among these models are attributable to the project. Predictions of regional economic activity over time can be compared to actual values, as a way to test the fit of the estimated regional economic linkages.

Data gathering and validation was a major component of the study. Sources of data for the four input models include hatchery planning documents

and information derived from agencies and contractors of similar projects. For example, the Proposed Master Plan (FMC 1987) was the primary source used to estimate hatchery construction costs, and to derive operations and maintenance estimates for the hatchery. Development of direct expenditures for the experimental and monitoring activities was based largely on information from existing contracts. A sensitivity analysis was used to describe a range of possible regional economic impacts relating to increased recreational fishing. Considerations included estimates of the net increase in harvestable fish, improved quality of fishing, and expenditures associated with behavior of the anglers. Direct expenditures from trival fishing was based on information concerning harvesting methods, numbers of fishers, composition of fishing groups, travel patterns, and known catch rates.

For the economic analyses, the program was divided into four major elements: construction, O&M, experimentation and monitoring, and harvest. Direct expenditures from four categories of activities were then inserted into the input-output and econometric models to generate estimates of indirect and induced impacts. The generation of expenditure estimates for the first three categories required adjustments for time, function, and geography. The development of fish harvest expenditures estimates was more complex and required assumptions about fishing techniques, catch rates, and travel distance.

Different estimation procedures were developed for the direct impacts stemming from each of the four categories of fishery enhancement activities. Construction expenditures were allocated into specific industrial sectors and assigned to specific counties and years. Broad measures of aggregated project spending was allocated into industrial sectors and specific counties to obtain direct expenditures resulting from operations and maintenance and experimentation and monitoring activities. Direct expenditures resulting from harvest activities included both sport fishing and tribal fishing components.

The project was estimated to develop 6,975 person-years of employment, $132,424,280 of income, and $33,859,760 of taxable sales in the study area from 1990 through 2015. In a typical year during the construction phase, the study area was estimated to experience increases of 143 jobs, $4,036,856 in income, and $8,753,135 in output. The construction sector will experience the

greatest change in output, whereas the service sector will experience the greatest increase in income and employment. In the peak construction year, sales tax collected in the region is estimated to increase by $587,970.

In a peak harvest year, the study area will experience estimated increased of 409 jobs, $8,507,806 in income; and $17,627,154 in output. The service and trade sectors are estimated to account for 82% of these changes. In the maximum production year, sales tax collected will increase by $691,690.

The overall increase in total economic activity will be brought about by the fishery enhancement project. Timing of peak impact events include a construction period impact peak occurring in 1994, a harvest impact peak in 2015, and a slight dip in regional economic activity commencing in 1995 and ending with the third year of harvesting in 2000. A level of economic activity is expected to be 2.8 times as great in the peak harvest year as in the peak construction year.

Anticipated benefits include increased employment in an areas generally suffering from high unemployment, stimulation of entrepreneurial activities in the study area, and a relatively steady increase in jobs and income. The new jobs will bring a mixed quality of employment to the region: high income employment will be associated with the construction, O&M, and experimentation and monitoring phases, while lower income employment will occur from service sector and trade activities during the harvest period.

The project is also predicted to aid in the structural evolution of the study area's economy. For example, gradual changes in sport fishing will induce increases in tourism. This shift into tourist-related activities will represent a new undertaking for much of the region. Examples of new enterprises include marinas, tackle sales, guide services, and traditional hospitality industries.

Program impacts will create jobs in the services and in the retail industries, particularly in the hospitality and recreational-related retain industries. Some of the employment generated by this project will have high incomes, including government employment in facility O&M, and onsite personnel employed in the experimentation and monitoring activities. However, a large portion of new employment will be in retail, recreational service, and

hospitality industries. These jobs tend to be low paying and often part-time. Overall, the jobs generated by the project will likely not reach the national average of quality for new service sector jobs. Although some of the stimulated economic sectors may result in national franchises moving Into the area, activities will also support local business entry.

A relatively steady building of jobs and income will occur because of the existence of continued O&M expenditures, and because the experimentation and monitoring expenditures will help balance reductions of construction expenditures. The addition of Phase II screening and enhancement construction will help to smooth the transition from hatchery construction activities. Additionally, increases in service sector activities during experlmentation and monitoring will modulate impacts of the strong service sector that are expected during the harvest period.

D. ENVIRONMENTAL ASSESSMENT

BPA prepared an EA in March 1990 for the YKPP as required 'by the National Environmental Protection Act (NEPA). A draft EA was submitted to public for review and comment in June 1989. The draft EA included several alternatives, including BPA's proposed action and a "no-action" (i.e., no project will be built) alternative. The current enhancement scenario for the YKPP was based on the EA, the results of the engineering feasibility study, experimental design, and baseline data.

The following major issues were analyzed in the EA conducted for the

Resident trout populations In the upper Yakima River may be adversely affected if the carrying capacity of the river Is approached.

Assessment: A research program is currently underway to monitor and evaluate interactions between supplemented species and trout. The potential introduction of exotic disease will be controlled through the careful screening of donor stocks originating outside the Yakima or Kl ickitat Rivers.

Concern: Genetic diversity of existing stocks may be adversely affected.

Assessment: Genetic diversity or genetic variance will be protected through the increase in population size, increased utilization of spawning areas, and the use of only naturally-spawned fish for

broodstock. Genetic diversity-of wild stocks will be closely monitored and evaluated to minimize any alteration potentially caused by hatchery operations.

- Concern: The project will alter existing water rights.

  Assessment: BPA will design the project to operate under the existing system of water deliveries and water management in the Yakima River basin. Additionally, BPA does not intend that the project be used as a justification to seek curtailment, modification, or changes in withdrawals, storage, delivery practices, or use of return flows. The project will not affect any agreements, rights, jurisdictions, or otherwise conflict with provisions described in the Columbia Basin Fish and Wildlife Program, Section 1500, Measure 1501, Items 1 through 7 (NPPC 1987).

- Concern: Water quality conditions will be affected.

  Assessment: Nutrient and biological oxygen demand levels in the Yakima subbasin would rise slightly due to water from hatchery discharge. However the worst-case analysis indicated that potential increases were small compared to existing levels and would not affect aquatic life. Hatchery facilities in the Klickitat subbasin would not affect river flow and would benefit water quality by removing suspended solids from the river.

- Concern: Facility development may increase the 100-year flood level.

  Assessment:, Mitigation measures will be required to assured that the 100-year flood level is not increased due to development of facilities located in designated floodways.

- Concern: Wetlands may be impacted by the YKPP.

  Assessment: Hatchery facilities have been located to avoid impacts to any wetlands., No net loss to wetlands will be caused by this project.

- Concern: Threatened or endangered species may be affected.

  Assessment: No sites currently considered for development contain rare species currently protected or considered for protection under the endangered species act. Proposed construction and operation of the facilities will have no effect on wintering bald eagles in either subbasin.

- Concern: Cultural resources will be impacted because of facility development.

  Assessment: Established archaeological site were identified at one of the alternative construction sites for both the Yakima and Klickitat subbasins. Elimination of these sites from further consideration is

recommended. A Determination of Eligibility will be sought prior to facility development for other construction sites.

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